FAA-G-2100F
November 15, 1993

U.S. Department
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U.S. Department of Transportation

Federal Aviation Administration

Specification

ELECTRONIC EQUIPMENT, GENERAL REQUIREMENTS

SPECIFICATION CHANGE NOTICE (SCN)

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This notice informs recipients that the specification identified by the number (and revision letter) shown in block 4 has been changed. The pages changed by this SCN (being those furnished herewithin) carry the same date as the SCN. The page numbers and dates listed below in the summary of changed pages, combined with nonlisted pages of the original issue of the revision shown in block 4, constitute the current version of this specification.

3. SCN No.	14. Pages changed	S*	A/D*	15. Date
Basic	This SCN incorporates the NCP 16024. FAA-G-21 OOF is reissued in its entirety.	S		November 15 1993

16. Technical Concurrence	17. Date
Howard R. Young	12/6/93

● S = Indicates Supercedes Earlier Pages A = Indicates Added Page D = Indicates Deleted Page

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FOREWORD

This specification contains the National Airspace System technical requirements for the design and construction of ground based electronic equipment. This revision (FAA-G-2100F) was prepared by RTCA Special Committee 175 and represents a joint effort by industry and FAA. This specification is to be used in conjunction with the project specification and statement of work and must be tailored to the specific procurement. **To assist in the tailoring decisions, Appendix I provides guidance on the applicability of each reauirement to Developmental, Non-Developmental Items (NDI), and Commercial-Off-The-Shelf (COTS) equipment.** The following subjects are covered within this specification:

a. Electrical

b. Mechanical

c. Parts, Materials, and Processes

d. Reliability/Maintainability

e. Environmental conditions

f. Electromagnetic Compatibility and grounding

g. Identification and marking

h. Human Engineering

i. Quality Assurance

j. Acceptance Tests

k. Packaging and shipping

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1.0 SCOPE AND PURPOSE

1.1 Scope. This specification is the technical baseline for ground based electronic equipment acquired for applications in the National Airspace System (NAS). This specification defines electronic equipment conditions which must operate satisfactorily and reliably: the materials and processes, the selection and application of parts, and the tests for electronic equipment. Individual electronic equipment specifications will identify applicable requirements of this specification.

1.1.1 Intended Use. This specification is to be used in conjunction with the equipment specification to establish the procurement requirements. This specification should not be invoked on a blanket basis in equipment specifications.

1.1.2 Tailoring of this Specification. This specification contains a set of requirements designed to be tailored for each contract by the government program office. The tailoring process for this specification is deletion of non-applicable requirements. **Appendix I provides guidance for tailoring the requirements for a Developmental, Non-Developmental (NDI), or Commercial-Off-The-Shelf (COTS) procurement.**

1.1.3 Classification. Electronic equipment acquisition alternatives which are available include NDI, COTS and developmental items. The selection of the appropriate acquisition alternative is the responsibility of the government program office, and should be dependent upon the expectations for the electronic equipment, availability of NDI or COTS equipment, and cost-benefit trade-offs. Specific acquisition requirements are the responsibility of the acquiring office, and will be tailored within the range of acceptable limits provided herein.

1.1.4 Specification Type. The equipment specification may be a performance specification, a design specification or a hybrid of performance and design specifications. If the acquisition is to be NDI or COTS, the equipment specification type should be a performance specification. If the acquisition strategy is for developmental hardware, then the equipment specification type may be either performance, a design, or a combined performance design specification. The decision regarding the specification type is the government program office's responsibility.

1.1.4.1 Performance Specification. A performance specification is an equipment specification in which the equipment, including hardware, firmware, and software are treated as a black box, and the interfaces to the equipment are specified. The government program office has the responsibility to ensure that equipment meets all specified performance characteristics.

1.1.4.2 Design Specification. A design specification is an equipment specification in which the equipment, including hardware, firmware, and software are specified to the module level. The acquisition office should specify the equipment design. The government program office has the responsibility to ensure that equipment meets all specified performance and design characteristics.

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2.0 APPLICABLE DOCUMENTS

2.1 Government documents. The listing of government documents referenced in this document is contained in Appendix II.

2.2 Non-Government documents. The listing of non-government documents referenced in this document is contained in Appendix III.

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3.0 REQUIREMENTS

3.1 General. Three levels of equipment requirements; developmental items, NDI and COTS are recognized herein. In addition to requirements for developmental items (custom designed and developed equipment), requirements that may be applied to NDI or COTS are provided. When the needs of the Federal Aviation Administration can be met without new development work, NDI or COTS procurements are preferred. However, this specification's requirements for NDI or COTS must be tailored for all procurements, or they can be used as a standard of comparison among competing NDI or COTS equipments. Equipment specifications, or statements of work, might invoke individual requirements from this specification which NDI or COTS items must meet in order to be considered for acquisition. It should also be noted that equipments procured using this specification might include subsystems, units, assemblies, or parts that are NDI or COTS. Where English units of measurements are cited, the use of metric units is not prohibited.

3.1.1 Definitions.

3.1.1.1 Commercial-off-the-Shelf (COTS). Commercial-off-the-shelf or commercial product. Items or equipment which has been developed independently by industry to meet market demands. These items may be commercial products as defined in the Federal Acquisition Regulations Part 11 or newly developed commercial items that have no market history. Within this document, COTS is a subset of Nondevelopmental Item (NDI).

3.1.1.2 Developmental Item. An item of supply, not previously available, developed uniquely to meet the requirements (performance and otherwise) of a specific procurement contract and/or equipment specification.

3.1.1.3 Fail-safe. A failure does not adversely affect the safety of the NAS. This means that a failure in the equipment itself or in the equipment's monitoring capability shall cause the system to shut down if this failure would result in a safety hazard to the NAS user. This also means that a failure in the equipment shall not create a safety hazard to the personnel who maintain the equipment.

3.1.1.4 Fail-soft. A failure in the equipment reduces the operational capability of the equipment but does not degrade the safety of the NAS. For example, when the (Remote Monitoring Subsystem) RMS of an equipment fails, the operational capability to remotely monitor and control the equipment is lost, but the equipment continues to operate safely with the local monitoring system. When the primary transmitter of a category II or III (Instrument Landing System) ILS fails, the equipment continues to operate safely on the standby transmitter, but the operational category is reduced to category I.

3.1.1.5 Modified COTS/Commercial Type Product. COTS equipment that has been modified to meet functional requirements. Also means a commercial product (a) modified to meet some Government-peculiar requirement or addition or (b) otherwise identified differently from its normal commercial counterparts. Within this document, modified COTS equipment is a subset of NDI.

3.1.1.6 NDI (Nondevelopmental Item). NDI equipment can be COTS, modified COTS, or previously developed. NDI shall be defined as any one of the following:

a. Item of supply that is available in the commercial marketplace (COTS).

b. Previously developed item of supply that is in use by a department or agency of the United States, a state or local government, or a foreign Government.

c. Item described above that requires only minor modification to meet the procuring agency's requirements (includes Modified COTS). Minor modifications are defined as modifications that do not adversely affect safety, durability, reliability, performance, interchangeability of parts or assemblies, maintainability, weight (where weight is significant), or any other significant objective of the end item. (See FAA Order 1810.6)

d. Item currently being produced that does not meet the above requirements solely because it is not yet in use, or not available in the commercial marketplace.

3.1.2 Electrical.

3.1.2.1 Electrical Wiring. Electrical wiring shall have, as a minimum, the following requirements:

a. All wiring external to the equipment that interfaces with the power source shall be in accordance with the National Electrical Code (NFPA 70).

b. The wiring external to the equipment that interfaces with the power source shall be in accordance with FAA-STD-032 and FAA-C-1217 if specified by the contract.

3.1.2.2 Alternating Current (AC) Supply Line - Circuit and Parts Requirements.

3.1.2.2.1 Alternating Current (AC) Line Controls. Each control switch, relay, circuit breaker, fuse or other device, which acts to disconnect the AC supply line energizing the equipment, shall be in accordance with NFPA 70 or the UL standard appropriate for the equipment (UL1950 for Information Technology Equipment).

3.1.2.2.2 Main power Switches. Switches or circuit breakers which function as main power switches, operating either directly or through a contactor to disconnect the AC line from the equipment shall break the AC line immediately after it enters the equipment via line filter, terminal block or connector, and before it reaches fuses or other parts.

3.1.2.2.3 Alternating Current (AC) Line - Input Resistance to Ground. For each individual chassis unit which is to be connected to the AC supply line, the DC resistance to ground from each input line terminal shall not be less than 1 megohm (AC supply line disconnected; fuses in place; AC line control contacts closed) or as specified in the UL standard appropriate for the equipment (UL1950 for Information Technology Equipment).

3.1.2.2.4 Alternating Current (AC) Line Connectors and Power Cord. Plugs, receptacles, and power cords provided for connection of the equipment to the AC supply line shall meet the requirements of NFPA70 and shall either be recognized components bearing the listing mark of Underwriters Laboratories, Inc., or other independent safety testing organization or be listed by such organization as part of the equipment or portion thereof. If specified by contract, the following requirements shall apply.

a. The plugs and receptacles shall conform to W-C-596 and the power shall be a minimum 3 wire cord conforming to J-C-580.

b. For 120 V, detachable power cords, the power cord shall be type SJ, 3-conductor cord in accordance with J-C-580. The equipment end of the cord shall have a female plug per DESC 87204. The supply end of the cord shall have a male plug end of the cord per W-C-596/13-3. The equipment shall have a male receptacle per DESC 87203 (which mates with the equipment end of the power cord) mounted in the lower right corner of the rear panel (viewed form the rear of the equipment).

3.1.2.2.5 Alternating Current (AC) Line Controls to be Provided. Each equipment unit energized by direct connection to the AC line shall have, as a minimum, the following AC line controls:

a. Front-panel mounted main power switch or circuit breaker, permitting manual control of the application and removal of on/off control AC line voltage to the equipment.

b. Front-panel mounted AC line indicator light.

c. Front-panel mounted AC line indicating type fuse-holders, if circuit breakers are not provided.

3.1.2.2.6 Transformer Isolation, DC Power Supplies (non-switching). All non-switching DC power supplies energized from the AC line power source shall be isolated from the AC line through a power transformer with separate primary and secondary windings. The DC resistance from each input line terminal (with fuses in place and AC line control contacts closed) to the signal or chassis ground shall not be less than 1 megohm.

3.1.2.2.7 Convenience Outlet. Convenience outlets provided on the equipment racks shall be a duplex isolated ground receptacles in accordance with W-C-596/12 or equivalent styles such as Hubbell #IG-5262, Bryant #5262-IG, Slater #IG-5262, or approved equivalent installed and wired in accordance with the NFPA 70.

Convenience outlets provided on UL listed equipment shall be in accordance with the UL standard appropriate for the equipment (UL1950 for Information Technology Equipment). Cabinet wiring design shall provide for power to these convenience outlets from an AC line power source independent of the equipment primary power source.

3.1.2.3 Circuit Protection. All equipment output circuits shall be designed to include circuit protection and prevent opens or shorts at the output terminals from damaging the equipment. When the short or open is removed, circuit performance shall show no sign of performance degradation. In addition, transmitter output circuitry shall be so designed that, when operated at any voltage standing wave ratio (VSWR), the unit shall not be damaged nor any part exceed dissipation limits. The transmitter may shut itself down upon detection of a high VSWR.

3.1.2.4 Power Source. The specific values of nominal voltage and frequency (also number of phases and wires required) shall be as established by the equipment specification.

3.1.2.4.1 Electrical Load Balance. When equipment requiring three-phase power is comprised of several single-phase subassemblies, the single-phase loads shall be balanced among the three phases so the total load on any one phase does not deviate from the average of the three phases by more than 10 percent under normal operating conditions.

3.1.2.4.2 Power Factor.. Power factor shall be defined as the absolute value of the product of the displacement component of power factor and the distortion component of power factor.

$$PF = |PF_{disp} * PF_{dist}|$$

The displacement component is defined as the cosine of the angle between voltage and current. This also equals power (Watts) divided by apparent power (VA).

$$PF_{disp} = \text{Cos (theta)} = \text{Watts/VA}$$

The distortion component is defined as one over the square root of one plus the square of the total harmonic distortion of the equipment.

$$PF_{dist} = \frac{1}{\sqrt{1 + (THD)^2}}$$

Power factor shall be within the range of values indicated below:

W(watts	PF(power factor)
W<2000	0.7(lag) - 0.7(lead)
2000 ≤ W ≤ 5000	0.8(lag) - 0.9(lead)
W>5000	0.9(lag) - 1.0.

3.1.2.4.3 Effect of Equipment on Power Source. The individual current harmonic distortion (I_N) produced by each individual equipment item or subsystem (consisting of several items combined in a single power circuit) shall not exceed the limits listed in Table I. Note that the total current harmonic distortion (THD) for equipment or subsystems requiring power of 40 kilowatts or more shall be limited to 10 percent. THD is defined in IEEE STD 519-1992, "IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems".

TABLE I. LIMITS OF INDIVIDUAL HARMONICS

Harmonic Order	Maximum Limits (ma) for 50 < W < 600 (1 phase)	Maximum Limits (ma) for 600 < W < 40K (1 or 3 phase)
2	1.00 x W	400 + (0.05 x W)
3	3.60 x W	1440 + (1.20 x W)
4	1.00 x W	400 + (0.05 x W)
5	2.00 x W	800 + (0.66 x W)
6	0.50 x W	200 + (0.02 x W)
7	1.50 x W	600 + (0.50 x W)
8	0.50 x W	200 + (0.02 x W)
9	1.00 x W	400 + (0.33 x W)
10	0.10 x W	100 + (0.01 x W)
11	0.60 x W	240 + (0.20 x W)
12	0.10 x W	100 + (0.01 x W)
13	0.51 x W	203 + (0.17 x W)
14	0.10 x W	50 + (0.01 x W)
15	0.44 x W	176 + (0.15 x W)
16	0.10 x W	50 + (0.01 x W)
17	0.39 x W	155 + (0.13 x W)
18	0.10 x W	50 + (0.01 x W)
19	0.35 x W	139 + (0.12 x W)
20	0.10 x W	50 + (0.01 x W)

NOTES:

1. W equals power in watts.

2. Power is active power in watts for both single phase and polyphase circuits as defined by ANSI/IEEE Standard 100, "IEEE Standard Dictionary of Electrical and Electronics Terms".

3. K equals 1000.

3.1.2.4.3.1 Inrush Current. The limits for inrush current shall be imposed at the point of connection to the facility power bus. The limits (overcurrent and duration) shall be as shown in Figure I., for loads greater than 600 watts. The limits for loads with power requirements of 600 watts or less shall not exceed 1.5 times the overcurrent values shown in Figure I.

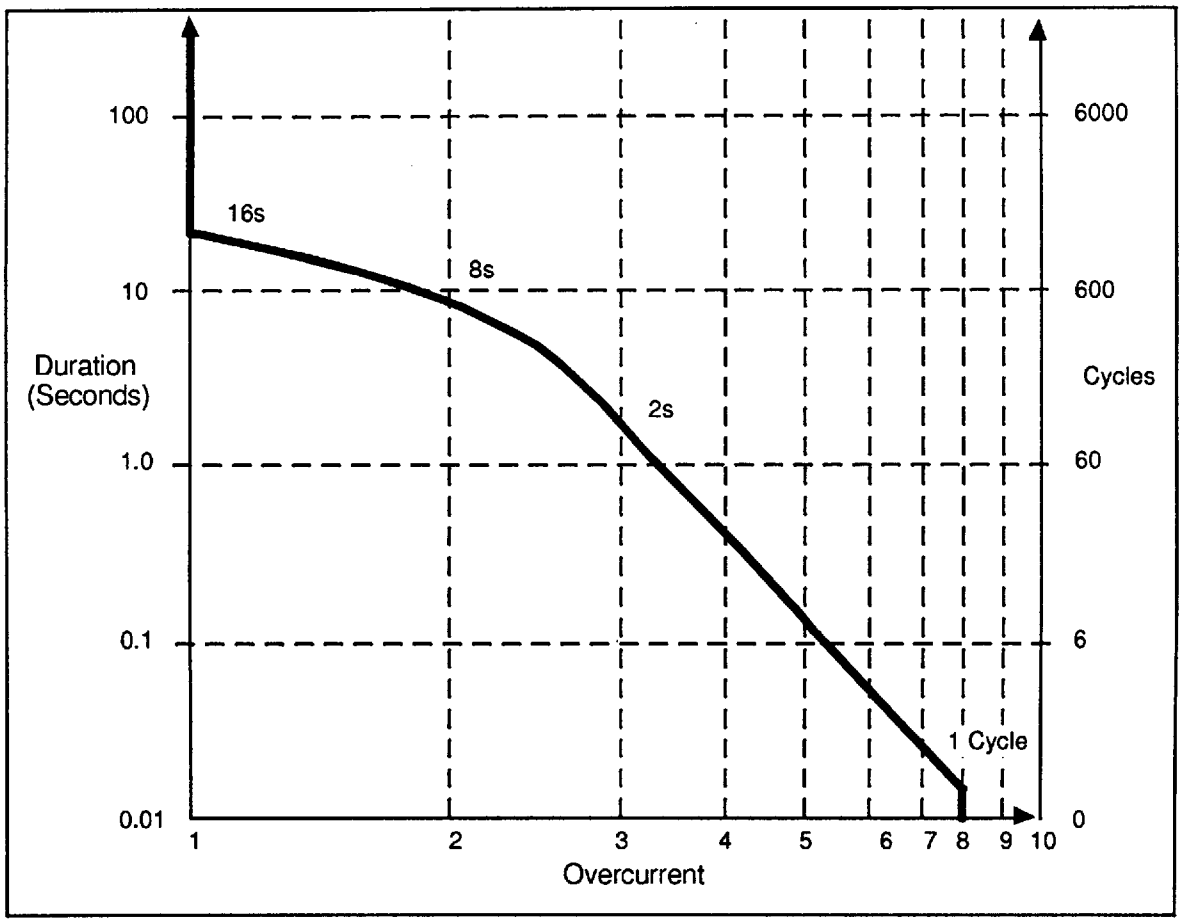


FIGURE I. INRUSH CURRENT LIMIT RATIO

3.1.2.4.4 Electrical Overload Protection. Electrical overload protection shall be as follows:

3.1.2.4.4.1 Current Overload Protection. Current overload protection for the equipment shall be provided by fuses, circuit breakers, or other protective devices for primary circuits.

3.1.2.4.4.2 Protective Devices. Devices such as fuses, circuit breakers, time-delays, cutouts, or solid state current-interruption devices shall be used to open individual leads of a circuit whenever a fault occurs. Circuit breakers are the preferred protective devices for wired-in equipment and shall be connected to the load side of the equipment power switch (main circuit power disconnect). For portable equipment, a separating connector or the attachment plug and receptacle shall serve as the main circuit power disconnect (the protective device may be on either the line side or the load side of the equipment on-off switch).

3.1.2.4.4.3 Circuit breakers. When circuit breakers are used, the restoring or switching device shall be readily accessible to the operator. The circuit breaker shall give a visual indication when the breaker is tripped. Holding the switching device closed on an overload shall not prevent tripping of the breaker. Three phase circuit breakers shall be used for three-phase equipment and shall disconnect all phases if an overload occurs in any one phase. Circuit breakers shall not be used as switches unless such breakers have been specifically designed and tested for that type service.

3.1.2.4.4.3.1 Short Circuit Coordination. Subsystems consisting of several devices or components shall be designed with properly rated protective devices that will provide selective fault isolation.

3.1.2.4.4.4 Normal Performance. The use of overload or other protective devices shall not alter the normal performance characteristics of the source or load.

3.1.2.4.4.5 Secondary Circuit. The use of protective devices in secondary circuits shall be held to a minimum. Cost and ease of replacement of the affected part or unit shall be included in the data used in determining the need for such protective devices.

3.1.2.5 Test Points, Test Facilities, and Test Equipment. Test points, test facilities, and test equipment (internal and external) shall be in accordance with MIL-STD-415 as modified by the following subparagraphs:

3.1.2.5.1 Requirements. Built-in test devices shall maintain their accuracy under all operating conditions required by the specification. These devices shall be provided with connections or access for their operational checkout or calibration.

3.1.2.5.2 Exceptions. The requirements for automatic checkout/automatic monitoring and built-in-test (BIT) capability of MIL-STD-415 shall not apply, unless specifically required in the equipment specification or statement of work.

3.1.2.5.3 Locations. Test points and controls for adjustment shall not be located in compartments with voltage points of 300 volts or more. All test points and controls for adjustments shall be located to preclude accidental shock to personnel engaged in normal operating or maintenance activities.

3.1.2.5.4 Protection. Protection shall be provided in the test point circuitry to prevent equipment damage caused by the external grounding of test points.

3.1.2.5.5 Failures. Provisions for testing shall be so designed that any failure of built-in-test (BIT) devices will not degrade equipment operation or cause equipment shutdown unless equipment is specifically designed to shut down in case of BIT device failure.

3.1.2.6 Corona Prevention. Corona and electrical breakdown prevention shall be as follows:

3.1.2.6.1 Corona Prevention. When equipment is terminated with the cabling or other accessory equipment with which it is intended to be used, and when operated under the specified service conditions of humidity, temperature, condensation and barometric pressure with the specified power source frequencies and voltages (including commonly recurring transients), the corona level shall be compatible with the specified electromagnetic interference requirements. The corona level shall not degrade the equipment performance beyond the specified limits and shall not produce long-term degradation of the

properties of materials or parts which may cause premature equipment failure. The corona extinction voltage shall be at least 150 percent of the peak circuit voltage, corresponding to the maximum specified steady-state root mean square supply voltage, at any point which does not involve materials resistant to the effects of corona. Corona inception and extinction voltages shall be in accordance with ASTM D1868. Sharp edges and points should be avoided on all metal parts which are included in high-intensity electric fields. These are elements which contribute to formation of corona discharge.

3.1.2.6.2 Electrical breakdown prevention. The equipment shall be designed and manufactured with electrical clearance spacing, leakage (migration/creepage) distances, and insulation levels adequate to prevent electrical breakdown under the specified service conditions of humidity, condensation, barometric pressure, temperature, service life, contamination, and operating voltage (including transients). Liquid dielectrics, gases other than ambient air, or pressurization to prevent electrical breakdown shall not be used unless specified by the detail equipment specification or approved by the government program office.

3.1.2.7 Grounding, Bonding, Shielding and Transient Protection. For developmental items, grounding, bonding, shielding and transient protection shall be as specified in FAA-STD-020. At the facility interface, the requirements for grounding, bonding, shielding and transient protection shall be in accordance with NFPA 70.

3.1.2.7.1 NDI Grounding, Bonding, Shielding and Transient Protection. For NDI, grounding, bonding, shielding and transient protection shall be as specified in FAA-STD-020 or, if the item is to be UL recognized, in accordance with the UL standard, i.e., UL1950 for Information Technology Equipment. In either case, at the facility interface, the requirements for grounding, bonding, shielding and transient protection shall be in accordance with NFPA 70 and shall not violate the requirements of FAA-STD-020.

3.1.2.8 Solid-State Design. The equipment shall make maximum use of solid state technology.

3.1.3 Mechanical.

3.1.3.1 Furnishing of Removable Parts and Mating Connectors. Each equipment furnished by the contractor shall be complete with an installed set of fuses, lamps, plug-in relays, plug-in crystals, ferrule-type resistors, and other parts which are used in the equipment and which are similarly designed for quick removal and replacement. This requirement does not apply to plug-in parts which provide expanded equipment capabilities not implemented as part of the contract. For example, spare card cage sockets and memory expansion sockets may remain empty unless specifically required otherwise by the equipment specification or statement of work. Parts which may be damaged by shipment in the operating sockets shall be packed in the normal part shipping container along with information to identify the operating socket. Where a coaxial or cable connector is provided on a piece of equipment furnished under the contract which will be connected to another piece of equipment not being furnished under the contract, the contractor shall supply the mating connector for the equipment under contract. Also, when two or more pieces of equipment furnished under the contract require interconnection, the contractor shall supply the necessary mating connectors. Telephone-type plugs and jacks, modular telephone plugs and jacks, and industry standard communications cables (such as RS-232 cables and connectors) are excluded from this requirement.

3.1.3.2 Installation. The equipment shall be so designed that it can be installed, removed, and reinstalled with a minimum of special tools and without extensive disassembly. In addition, the following also apply:

3.1.3.2.1 Pull-Out Drawers. All equipment pull-out drawers shall be of a full-suspension roller type with latching stops. Friction-slide construction is prohibited. Slides shall be of sufficient rigidity to prevent bowing and/or having rollers jump their track. Drawers shall be equipped with handles to permit withdrawing the drawer into the open position and latches on active panel fasteners to secure the drawer in the closed position.

3.1.3.2.2 Rack Panels. Where rack panels are used, they shall be in accordance with ANSI/EIA 310, Standard RS-310-C-77. Panel slot/hole pattern shall be the universal hole spacing pattern for 1U, 2U, and 3U panels and the wide hole spacing for panels 4U and higher. Nominal thickness for aluminum panels shall be 3/16 inch, or greater. Nominal thickness for steel panels shall be at 1/8 inch or greater. Exceptions for NDI require the approval of the FAA.

3.1.3.3 Construction. The equipment shall be constructed so that:

a. no fixed part shall become loose,

b. no movable part or permanently set adjustment shall shift its setting or position, and

c. no degradation shall be caused in the performance specified in the equipment specification under all specified operating conditions.

3.1.3.3.1 Storage. Equipment packaged for storage shall meet all specified performance requirements for a minimum storage period of two years, or as specified in the contract.

3.1.3.3.2 Moisture Pockets. Pockets, wells, traps, and the like in which water or condensation could collect when the equipment is in normal position shall be avoided. Where moisture pockets are unavoidable and the equipment is not sealed, a provision shall be made for drainage of such pockets. Desiccants or moisture-absorbent materials shall not be used within moisture pockets. Where moisture buildup cannot be tolerated in sealed equipment or assemblies such as waveguides, the use of desiccants or other methods, such as gas purging, shall be considered.

3.1.3.3.3 Windows. Unless it interferes with equipment operations, equipment windows, including dial windows, shall be shatterproof clear glass, or heat resistant plastic secured to the panels in bezels by means of clips or other devices to prevent displacement of the glass. Use of adhesives to secure windows requires FAA approval.

3.1.3.4 Accessibility. Equipment shall be designed for optimum accessibility, operating compatibility, maintenance, electromagnetic compatibility, and enclosure requirements. For nonstructural purposes, all non-hinged shields or plates which are normally opened or removed in servicing an equipment, shall be secured with captive fasteners. Such fasteners shall be spaced on centers not exceeding 10 inches and shall be located around the entire periphery of the shields or plates.

3.1.3.4.1 Access. Each article of equipment and each major subassembly forming a part thereof shall provide for the necessary access to its interior parts, terminals, and wiring for adjustments, required circuit checking, and the removal and replacement of maintenance parts. Accessibility for testing and replacement does not apply to parts located in nonrepairable subassemblies or assemblies. For routine servicing and maintenance, unsoldering of wires, wire harnesses, parts or assemblies shall not be required in order to gain access to terminals, soldered connections, mounting screws and the like. Inspection windows shall be provided wherever necessary. Sizes of openings, maximum reach requirements, and allowable sizes and weights of replaceable assemblies shall conform to Paragraph 3.3.7.

3.1.3.4.2 Connections. Connections to parts inside a removable container shall be arranged to permit removal of the container without threading connection leads through the container.

3.1.3.4.3 Parts. Parts which are identified as replaceable parts for the equipment shall be removable and replaceable. These parts shall not be mounted by means of rivets, spot welding, or hard curing compounds. If, in order to check or remove a part, it is necessary to displace some other part, the latter part shall, whenever practicable, be so wired and mounted that it can be moved without being disconnected and without causing circuit detuning or instability. No unsoldering or soldering of connections shall be necessary when the front panel or any subchassis is removed for maintenance purposes. Design shall be such that where plug-in modules or assemblies are used, they can be inserted in the proper location when correctly oriented without damage to equipment or parts being engaged. Plug-in modules and assemblies shall be designed to prevent insertion into the improper location or incorrect orientation.

3.1.3.4.4 Enclosures. Accessibility to chassis, assemblies, or parts contained within cabinets, consoles or other enclosures shall be provided from outside the basic equipment through the use of access doors. Mounting such items on withdrawal slides, swinging doors, through cable extenders and cable retractors, and provisions for circuit card extenders shall allow part or module operation in the open position. Automatic or manually operated locks shall be provided to lock the chassis in the servicing position. When withdrawal slides are used they shall be of guided sectional construction with tracks and rollers. Complete removal and access for servicing of electronic equipment contained within cabinets, consoles or other enclosures shall be provided from either the front or rear of the equipment. Guide pins (or locating pins), or the equivalent, shall be provided for mechanical alignment during mounting.

3.1.3.5 Thermal Design. Paragraphs 3.1.3.5.1, and 3.1.3.5.4 do not apply for NDI and COTS. Developmental items for the thermal design shall be in accordance with the following:

3.1.3.5.1 Air Filters. Equipment design requiring an air flow velocity through the filter not exceeding 300 feet per minute (FPM), disposable one inch thick impregnated glass wool filters per Federal Specification A-A-1419 shall be used. Air flow velocities through the filter exceeding 300 FPM, metal washable type filters in accordance with MIL-F-16552 shall be used. Air flow velocity through the metal filter shall not exceed 400 FPM. Filters shall not project outside the equipment enclosure and shall be removable from the outside (exterior) of the equipment cabinets without the necessity of opening access doors or moving any other equipment cabinets. Personnel shall be protected from harm of moving parts when replacing filters. Shutdown of fans shall not be required for filter replacement.

3.1.3.5.2 Exhaust Air Temperature. The exhaust air temperature, measured inside the cabinet or console in front of the exhaust air vent, shall not exceed the input air temperature, (measured outside the cabinet or console directly in front of the input air vent,) by more than 15°C with the equipment operating under normal service conditions.

3.1.3.5.3 Auxiliary Heating or Cooling. Auxiliary heating or cooling means or devices may be employed when the equipment is to be operated for prolonged periods for test and checkout purposes and when such periods are not consistent with normal service conditions.

3.1.3.5.4 Forced Air Cooling. Forced air cooling shall be used only when natural cooling cannot provide sufficient cooling or when a significant reduction in overall size and weight can be realized. The design factors to be considered in determining the required fan or blower characteristics include such factors as amount of heat to be dissipated, the quantity of air to be delivered at the pressure drop of the enclosed equipment, the allowable noise level, the permissible level of heat that may be exhausted into the surrounding environment, and other pertinent factors affecting the cooling requirement of the equipment. Miniature blowers shall conform to MIL-B-23071. Induced drafts and ventilation by means of baffles and internal vents shall be used to the greatest practicable extent. Air filters shall be provided for air intakes for fan and blower cooled units unless the cabinet containing the unit has an air intake filter. All ventilation openings shall be designed and located to comply with electromagnetic interference, undesired radiation and enclosure requirements. Air exhaust shall be directed away from operating personnel.

a. External supplied cooling air that may contain water or other contaminants shall not be detrimental to the equipment. Precautionary measures shall be taken to avoid direct impingement on internal parts and circuitry by channeling, or use of heat exchangers. If this is impractical, the water and contaminants shall be removed from the cooling air by suitable water and contaminant removal devices. To maintain consistency with adequate cooling, the minimum differential pressure (pressure drop) of the cooling air through the equipment heat exchanger or cold plate shall be maintained. Each separate piece of equipment being cooled shall be marked with the high and low operating temperature to which it is designed, the quantity and characteristics of air required to adequately cool the unit, and the resistance to air flow with respect to the air flow rate.

b. In the event of failure of the cooling device, an air flow interlock shall be used to provide a visual or aural warning.

NOTE: MIL-HDBK-251 may be used as a guide for detail information on thermal design of electronic equipment.

3.1.3.5.5 Other Cooling Methods. Cooling methods such as liquid, evaporative coolants, and vapor cycle refrigerants shall not be used.

3.1.4 Software. Software shall be in accordance with the equipment system/subsystem specification requirements.

3.1.5 Remote Maintenance Monitoring. Remote maintenance monitoring (RMM) shall be in accordance with the equipment system/subsystem specification requirements.

3.2 Characteristics.

3.2.1 Performance.

3.2.1.1 Continuous Unattended Duty. The equipment shall be designed for continuous unattended duty unless specifically stated otherwise.

3.2.1.2 Design Ranges. The following design ranges shall be used in the design and evaluation of developmental items and in the evaluation of NDI:

3.2.1.2.1 Nominal Design and Normal Test Values. Nominal design and normal test values are shown in Table II. Applicable values shall be as specified in the equipment specification or statement of work. Calculations which verify performance shall use the values specified. Normal testing which verifies performance shall control the nominal values within the indicated tolerance. Normal testing need not be repeated at the tolerance extremes in Table II.

TABLE II. NOMINAL DESIGN AND NORMAL TEST VALUES

PARAMETER	VALUE	TOLERANCE
Ambient temperature	+30°C	± 10°C
AC line voltage	120 V 208 V 240 V	± 2 V ± 3.5 V ± 4 V
AC line frequency	60 Hz	± 0.5 Hz
DC voltage	48 V 24 V	± 1 V ± 1 V

3.2.1.2.2 Environmental Design Values. Climatic values for standard environments are shown in Table III. Calculations which verify environmental compatibility shall use the values specified for both extremes of the ranges. Environmental testing shall be as specified in the equipment specification or statement of work. The equipment shall be designed to operate in one of the environments specified in Table III.

3.2.1.2.3 Wind and Ice Loading. Wind and ice loading values for standard outdoor environments are shown in Table III. The equipment shall withstand these combined factors without permanent deformation or change that would impact upon critical performance parameters.

3.2.1.2.4 Non-Operating Conditions. Turnkey equipment which is to be delivered by the contractor directly to the government end user in an installed and operational configuration shall be capable of withstanding the specified environmental conditions from Table III or the actual conditions to be encountered prior to government acceptance. Equipment which is to be delivered to the government packaged for storage, shipping or transporting (non-operating) shall, as packaged, withstand the following environmental conditions:

(a) Temperature -50°C to +70°C

(b) Relative humidity Up to 100% including condensation due to temperature changes

(c) Altitude 0 to 50,000 feet above sea level

TABLE III. ENVIRONMENTAL CONDITIONS

ENVIRON-MENT (note 1)	TEMP. (°C)	REL HUM. (%) (note 3)	ALTITUDE (ft above sea level)	WIND (mph)	ICE LOADING
I	+10 to +50	10 to 80	0 to 10,000	—	—
II	-10 to +50	5 to 90	0 to 10,000	—	—
III (note 4)	-50 to +70 (note 2)	5 to 100	0 to 10,000	0 to 100	Encased in 1/2"radial thickness clear ice
IV Environment IV is no longer used. Refer to III					
V	+10 to +40	30 to 80	0 to 10,000	—	—

NOTES:
1. I For equipment installed in an attended facility.
   II For equipment installed in an unattended facility.
   III For equipment installed outdoors (antennas, field detectors, etc.).
   IV This environment is no longer used. See environment III.
   V For equipment installed in controlled environment.
2. Includes 18°C for solar radiation.
3. Above 40°C, the relative humidity shall be based upon a dew point of 40°C.
4. Conformal coating is required only when equipment is exposed to salt atmosphere or located in tropical climate.

3.2.1.2.5 Voltage Range Test Conditions. The voltage range test conditions are as shown in Table IV. Developmental items shall operate throughout the specified ranges. NDI shall not be damaged by sustained attempted operation at any value within the specified ranges.

3.2.1.3 Operation Under Varying Conditions. All specification requirements for operation shall be met when the equipment is operated at the specified duty cycle, and under all fixed or slowly varying conditions of AC line voltage and frequency, and DC voltage, within the ranges specified in Table IV. Under these varying conditions, the specification requirement for the equipment voltages, currents, power dissipation and temperature, as applicable to specific parts and materials of the equipment, shall not be exceeded in starting and operating the equipment.

TABLE IV. VOLTAGE AND FREQUENCY RANGE TEST CONDITIONS

AC Voltage (120 V)	104 V to 127 V	(± 1 V)
AC Voltage (208 V)	181 V to 220 V	(± 2 V)
AC Voltage (240 V)	209 V to 254 V	(± 2 V)
AC Line Frequency (60 Hz)	57 Hz to 63 Hz	(± 0.2 Hz)

NOTE: Where discrete values of the above frequency or voltages are specified for testing purposes, the tolerances given in parentheses shall apply to those parameters as they are indicated on the measuring instruments specified in Paragraph 4.3.5.

3.2.1.4 Fixed Adjustment Provision. The equipment shall be initially set up and adjusted under the normal test conditions, following the procedures in the equipment instruction book or approved test procedures. No further adjustments shall be performed during testing for the entire cycle of test.

3.2.1.5 Equipment Response to Input Power Conditions. The contractor shall provide equipment which, as a minimum, operates compatibly within the voltage tolerance envelope as shown in IEEE Standard 1100 and described as "Typical Design Goals of Power Conscious Computer Manufacturers" in Figure II. The equipment shall be protected against damage and shall not produce false data or signals due to voltage conditions outside the tolerance envelope. Additionally, the manufacturer shall identify the equipment response to voltage conditions outside the normal envelope.

3.2.2 Physical Characteristics.

3.2.2.1 Electronic Equipment Assembly Requirements. The requirements and acceptance criteria for COTS and NDI electronic equipment assemblies, sub-assemblies, printed wiring assemblies, terminal board assemblies, electronic modules, etc., shall conform to the requirements specified below for Class 2 as defined ANSI/J-STD-001. All developed products shall meet the requirements for Class 2 or Class 3, as specified by the contract.

3.2.2.1.1 Soldering and Assembly. Soldering shall be in accordance with ANSI/J-STD-001.

3.2.2.1.1.1 Fluxes. The use of fluxes shall be in accordance with ANSI/J-STD-001.

3.2.2.1.1.2 Other Fluxes. Other fluxes (such as type RA or WS (water soluble)) require written approval from FAA, prior to use. Requests for such approval shall include:

a. Detailed cleaning procedure.

b. Insulation resistance test methods.

c. Minimum insulation test values (nominally 100 megohms).

3.2.2.1.2 Component Mounting. Component mounting procedures and requirements shall be in accordance with IPC-CM-770 or IPC-CM-780, as applicable, except the term 'not recommended' shall be interpreted as 'reject'.

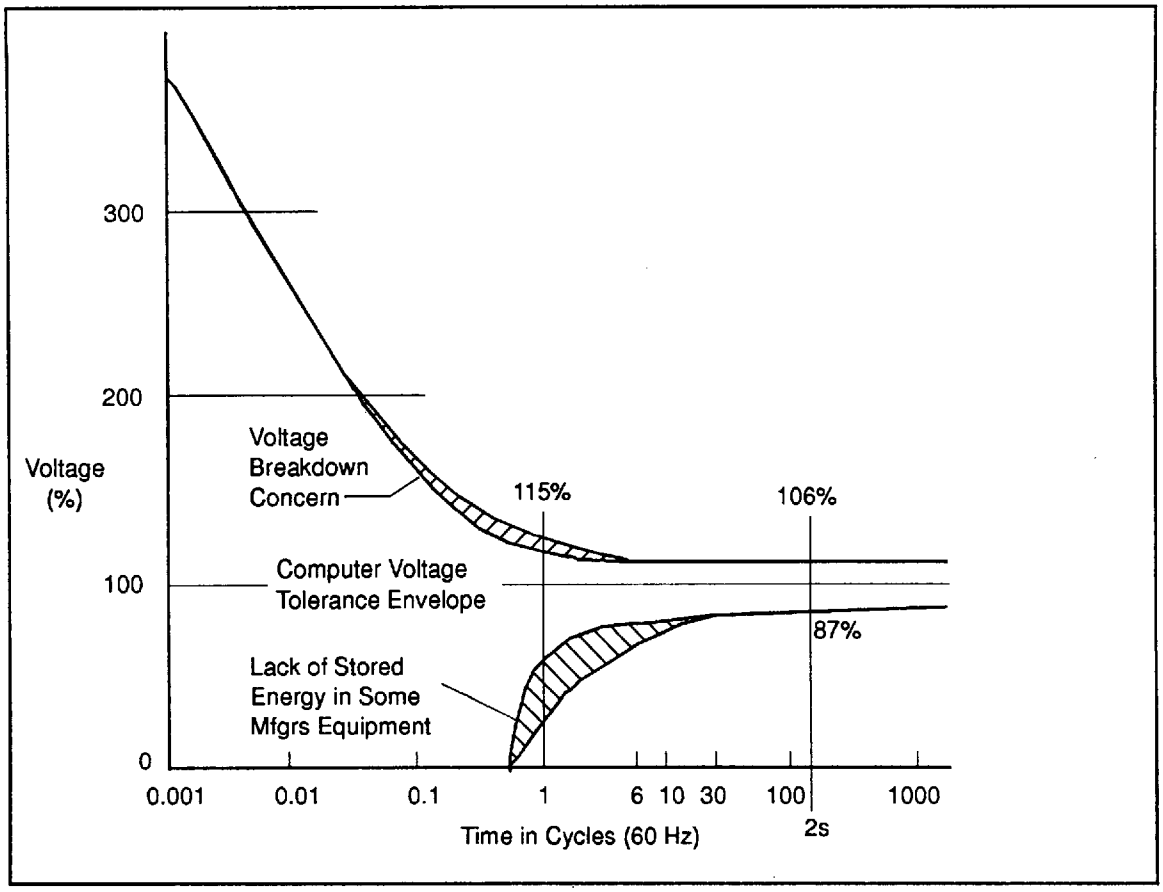


FIGURE II. TYPICAL DESIGN GOALS OF POWER-CONSCIOUS COMPUTER MANUFACTURERS

FIGURE III. RESERVED

TABLE V. RESERVED

3.2.2.1.3 Printed Boards. After exposure to manufacturing/assembly process, the printed board acceptance requirements shall be in accordance with IPC-A-600.

3.2.2.1.4 Assembly Requirements. Assembly requirements shall be in accordance with ANSI/IPC-A-610 and ANSI J-STD-001.

3.2.2.2 Wire Wrap. For COTS and NDI, the use of wire wrap shall be determined by the contract. For developed products, the use of wire wrap is prohibited on printed circuit boards, except as defined in Paragraph 3.3.1.2.7.

3.2.2.3 Certification. All operators, instructors, and inspectors, prior to commencing work, shall have been trained and be able to present evidence that they are proficient as required in Section 3.6 of ANSI J-STD-001.

3.2.2.4 Reference Designations. For mechanical parts, see Paragraph 3.3.3.2.2.10. Reference designations shall be assigned (and marked) in accordance with ANSI/IEEE-200, modified as follows:

a. Paragraph 4.1.5.5, third paragraph, line 5; delete 'may' and substitute 'shall'.

b. Delete text of Paragraph 4.1.8 and substitute "If a part serves a function other than the function for which it is designed, or a dual function, it shall nevertheless be represented on the schematic diagram by the graphic symbol and reference designation (latter chosen from Section 22 of ANSI/IEEE 315-75) indicative of the physical characteristics of the part. Where space permits, the special function shall be noted on the diagram; in any case, it shall be described in the instruction book for the equipment."

c. Delete subparagraph (3) under Paragraph 8.1.

d. Delete Section 10.

3.2.3 Reliability. When required by contract, the contractor shall implement and maintain a reliability program in accordance with the requirements of MIL-STD-785 as tailored. Unless otherwise specified by the equipment specification or statement of work, the program shall include the following reliability tasks.

3.2.3.1 Subcontractor Surveillance and Control (Task 102) When required by contract, reliability requirements applicable to the contractor shall be flowed down to subcontractors and suppliers. The contractor shall attend and participate in subcontractor's reviews as well as provide for subcontractor representation to Government reviews. This requirement shall not apply to COTS equipment, unless specifically required.

3.2.3.2 Program Reviews (Task 103). When required by contract, the contractor shall host and conduct reliability program reviews at specified points during the life of the contract. Appropriate scheduled reviews shall be held with major subcontractors and the Government shall be informed of each review.

3.2.3.3 Failure Reporting, Analysis, and Corrective Action (Task 104). When required by contract, the contractor shall establish and maintain a closed loop Failure Reporting, Analysis, and Corrective Action System (FRACAS) at contract specified levels or LRU level of the system.

3.2.3.4 Reliability Predictions (Task 203). When required by contract, the contractor shall estimate the system mean time between failure (MTBF) and the mean time between critical failures (MTBCF) by performing reliability predictions in accordance with the techniques of MIL-HDBK-217 and MIL-STD-756. Failure capable components shall be estimated including electrical, electro-mechanical, and mechanical components. When substantiated field data is available for COTS or NDI equipments, parts, subassemblies, or assemblies, such data may be used to derive failure rates for use in lieu of rates calculated by the component-by-component techniques of MIL-HDBK-217. All such data used for the derivation of failure rates shall be provided along with the system level predictions to illustrate that the selected design is predicted to meet the specified MTBF and/or MTBCF design requirements.

3.2.3.5 Parts Control Program (Task 207). When required by contract, the contractor shall implement a parts control program for the selection and use of standard and non-standard parts. When levied by contract, the contractor shall establish a parts control program in accordance with the requirements of MIL-STD-965. Non-standard components selected for use in the system design shall be approved prior to use by the Government. This requirement shall not apply to COTS equipment, unless specifically required. See paragraph 3.3.1.3.

3.2.4 Maintainability. When required by contract, the contractor shall implement and maintain a maintainability program in accordance with the requirements of MIL-STD-470 as tailored. Unless otherwise specified by equipment specification or statement of work, the program shall include the following maintainability tasks.

3.2.4.1 Subcontractor Control and Surveillance (Task 102). When required by contract, the contractor shall insure that equipment obtained from subcontractors/suppliers meet maintainability specification and statement of work requirements. Maintainability requirements applicable to the contractor shall be flowed down to subcontractors and suppliers. The contractor shall attend and participate in subcontractors maintainability reviews as well as provide for subcontractor representation to Government reviews. This requirement shall not apply to COTS equipment, unless specially required.

3.2.4.2 Program Reviews (Task 103). When required by contract, the contractor shall schedule and conduct maintainability program reviews at specified points during the life of the contract. Scheduled reviews shall be conducted on subcontracts exceeding $500,000 in value and the Government shall be informed of each review.

3.2.4.3 Maintainability Predictions (Task 203). When required by contract, the contractor shall estimate the system and subsystem mean time to repair (MTTR) by performing maintainability predictions on the system for each associated level of maintenance. Maintainability predictions shall apply to COTS equipment when specified by contract. Maintainability predictions shall be performed in accordance with MIL-HDBK-472.

3.2.4.4 Maintainability Demonstration. Maintainability tests shall be conducted on systems/subsystems/equipment representative of the production configuration. Maintainability demonstrations shall be performed in accordance with MIL-STD-471. A Government approved test catalog of failure modes shall be used as the basis for maintainability demonstration. Test duration shall be as identified by the Government. Testing shall be used to demonstrate the achievement of quantitative maintainability predictions that are consistent with specification and statement of work requirements.

3.2.5 Fail-safe Equipment Operation. The equipment shall be designed so that any failure in the equipment shall not degrade the safety of the NAS. When required by contract, the contractor shall demonstrate that the equipment is fail-safe.

3.2.6 Fail-soft Remote Maintenance Monitor Operation. Remote maintenance shall be designed so that a failure in the Remote Monitoring Subsystem (RMS) shall not otherwise affect the equipment operation. When required by contract, the contractor shall demonstrate that the RMS is fail-soft.

3.2.7 Environmental Conditions. The equipment environmental conditions will be in accordance with the equipment specification/statement of work. Refer to paragraph 3.2.1.2.2.

3.2.8 Transportability. Transportability will be in accordance with the equipment specification/statement of work.

3.3 Design and Construction. The equipment shall be designed to meet the requirements of the equipment specification and as specified herein. Approval shall be obtained from the Contracting Officer before permitting any deviations from a specified design requirement.

3.3.1 Materials, Processes, and Parts

3.3.1.1 Materials. For developmental items, materials shall be selected and used as specified herein. Materials specifically stated to be acceptable herein shall be considered standard materials and do not require additional review by the FAA. All other materials, whether mentioned herein or not, are subject to FAA review and approval prior to their use.

3.3.1.1.1 Arc-resistant Materials. Materials used for insulation of electrical power circuits where arc-resistance is required shall withstand a minimum of 115 seconds when subjected to the arc-resistance test of ASTM D495. Table VI lists materials which have been shown to comply with this requirement and which may be chosen without further verification of compliance herewith. Appearance in Table VI does not constitute approval of a material for use except from the viewpoint of minimum arc-resistance. These materials shall be masked, if necessary, during any treatment of the equipment in which they are used which might result in degradation of the arc-resistant properties of the material. When evaluating arc-resistant materials, consideration should also be given to their electrical and thermal characteristics when subjected to the specified conditions.

TABLE VI. ARC-RESISTANT MATERIALS

MATERIALS	SPECIFICATION	TYPES
Ceramic	MIL-I-10	All
Plastic, thermosetting, molding	MIL-M-14	CMI-5, GDI-30, GDI-30F, MAG, MAI-30, MAI-60, MAI-100, MAT-30, MDG, MME, MMI-5, MMI-30, MSG, MSI-30, SDG, SDG-F, SDI-30
Molding, epoxy compounds	MIL-M-14	MEE
Laminated rods and tubes	MIL-I-24768, 18, 110 through 114,116	GMG
Laminated sheets:		
Glass cloth, melamine resin	MIL-I-24768, 11	GME
Glass cloth, polytetra-fluoroethylene resin	MIL-I-24768, 17	GTE
Glass cloth, silicone resin	MIL-I-24768, 117	GSG
Low pressure laminate, silicone resin, glass fiber base	MIL-P-25518	All
Sheet and rod, cast	L-P-516	E-2
Sheet and strip, polyimide	MIL-P-46112	All
Silicone rubber	ZZ-R-765	All

3.3.1.1.2 Dissimilar Metals. Selection of metals for use in electronic equipment shall be made in accordance with the requirements of MIL-STD-889. Where electronic design requirements preclude the insolation of incompatible metal combinations as identified in MIL-STD-889 from one another, specific attention shall be paid to isolating the combination from exterior environments.

3.3.1.1.3 Metals, Corrosion Resistance. Metals shall be corrosion resistant or shall be coated or metallurgically processed to resist corrosion. Materials and processes for metallic parts shall conform to applicable requirements in MIL-STD-889 and MIL-STD-1516. Coatings shall be selected from MIL-STD-1516. Non-corrosion resistant steel alloys, except where specifically required for electronic purposes shall not be used.

3.3.1.1.3.1 Corrosion-resisting Ferrous Alloys. Austenitic corrosion-resisting steel shall be used for all structural parts which will be subjected to severe corrosive conditions, such as exposure to sea water and combustion gases. Corrosion-resisting steels shall be given a passivation treatment. Other protective finishes or platings are permitted for electrical or mechanical reasons. (See Paragraph 3.3.1.2.6).

3.3.1.1.3.2 Iron and Steel. The use of iron or steel shall be kept to a minimum commensurate with strength requirements. Where closures, cases, frames, panels, brackets, and miscellaneous hardware are fabricated of steel, such material shall be treated to prevent corrosion. Ordinary iron and steel shall be plated or finished to resist corrosion, except for the following conditions:

a. Iron or steel lamination used in magnetic circuits which are otherwise protected against corrosion.

b. Ferrous metal mechanisms that are bathed in oil or packed in grease, potted, or hermetically sealed, shall not require protective coatings.

3.3.1.1.4 Fibrous Material, Organic. Organic fibrous material shall not be used.

3.3.1.1.5 Flammable Materials. Materials used shall, in the end item configuration, be noncombustible or fire retardant in the most hazardous conditions of atmosphere, pressure, and temperature to be expected in the application.

3.3.1.1.5.1 Additives. Fire retardant additives may be used provided they do not adversely affect the specified performance requirements of the basic materials. Fire retardants shall not be achieved by use of nonpermanent additives to the basic material.

3.3.1.1.6 Fungus-inert Materials. Materials used, except those used within a hermetically sealed assembly, shall, in their end item configuration, be fungus-inert. Materials listed in Group I of Table VII have been shown to be inherently fungus-inert and need not be tested for fungus resistance prior to use and are preferred. Appearance in Table VII does not constitute approval of a material for use except from the viewpoint of resistance to fungi. Materials listed in Group II of Table VII have been shown to be fungus nutrient in some configurations and shall be demonstrated to meet the fungus resistance requirements specified below.

3.3.1.1.6.1 Fungicide Treatment. When materials not listed in Group I of Table VII must be used, they shall be rendered fungus inert by compounding with a permanently effective fungicide or by suitable surface treatment. There shall be no loss of the original electronic or physical properties required by the basic material specification. Fungus resistance shall be demonstrated as specified below.

3.3.1.1.6.2 Fungus Testing. Materials other than those listed in Group I of Table VII shall pass the fungus test specified in ASTM G21. There shall be no visible growth of fungus after 28 days. Certification by a qualified laboratory or by the material producer, based upon test data on record, will be sufficient evidence of acceptability.

TABLE VII. FUNGI SUSCEPTIBILITY OF MATERIAL

GROUP I. (Fungus-inert in all modified states and grades)	
Acrylics Acrylonitrile-styrene Acrylonitrile-vinyl-chloride copolymer Asbestos Ceramics Chlorinated polyether Fluorinated ethylenepropylene copolymer (FEP) Glass Metals Mica Plastic laminates: Silicone-glass fiber Phenolic-nylon fiber Diallyl phthalate Polyacrylonitrile	Polyamide Polycarbonate Polyester-glass fiber laminates Polyethylene, high density (above 0.940) Polyethylene terephthalate Polyimide Polymonochlorotrifluoroethylene Polypropylene Polystyrene Polysulfone Polytetrafluorethylene Polyvinylidene chloride Silicone resin Siloxane-polyolefin polymer Siloxane-polystyrene
GROUP II. Not fungus-resistant in all grades; fungus-resistance established by test)	
ABS (acrylonitrile-butadiene styrene) Acetal Cellulose acetate Epoxy-glass fiber laminates Epoxy-resin Lubricants Melamine-formaldehyde Organic polysulphides Phenol-formaldehyde Polydichlorostyrene	Polyethylene, low and medium density (0.940 and below) Polymethyl methacrylate Polyurethane (the ester types are particularly susceptible) Polyrichinoleates Polyvinyl chloride Polyvinyl chloride-acetate Polyvinyl fluoride Rubbers, natural and synthetic Urea-formaldehyde

NOTE: Literature shows that under certain conditions polyamides may be attacked by selective micro-organisms.

3.3.1.1.6.3 Process Materials. Processing materials to be tested for fungus resistance, such as paint, ink, coatings, adhesives, lubricants, viscous damping fluids, silicone grease, etc, shall be prepared in the form of squares or circles no more than 1/16-inch thick for testing. Liquid or paste materials shall be prepared by impregnating to saturation a sterile sample of glass fabric squares or circles no more than 1/16-inch thick for testing. Liquid or paste materials shall be prepared by impregnating to saturation a sterile sample of glass fabric.

3.3.1.1.7 Insulating Materials, Electrical. Insulating materials shall be selected based on meeting or exceeding the use requirements of the following:

a. Temperature endurance

b. Moisture absorption and penetration.

c. Fungus resistance.

d. Dielectric strength.

e. Dielectric constant.

f. Mechanical strength.

g. Dissipation factor.

h. Ozone resistance.

i.. Flammability.

3.3.1.1.7.1 Polyvinyl Chloride. Polyvinyl chloride insulating materials for external cables shall be in accordance with NFPA-70.

3.3.1.1.7.2 Ceramics. Ceramic compounds shall conform to MIL-I-10. Ceramic insulators shall conform to MIL-I-23264.

3.3.1.1.7.3 Electrical Tape. Cotton and linen tapes shall not be used.

3.3.1.1.7.4 Sleeving. Sleeving shall provide adequate dielectric strength and leakage resistance under the designated service conditions.

3.3.1.1.7.5 Plastic, Thermosetting, Cast. When used for electrical insulation, parts fabricated from cast thermosetting plastic shall be in accordance with L-P-516.

3.3.1.1.7.6 Plastic, Thermosetting, Laminated. The preferred base is glass cloth. Electrical insulators fabricated from laminated thermosetting-plastic sheets, plates, rods, and tubes (except transparent plastics) shall be treated for moisture resistance with a suitable moisture barrier after all machining and punching operations unless the plastic has a moisture absorption of 1.0 percent or less or is used in a hermetically sealed container.

3.3.1.1.7.7 Plastic, Thermosetting, Molded. Molded parts which undergo subsequent machining shall be vacuum impregnated with a suitable moisture barrier material and dried after all surface-breaking operations have been completed. Cotton and linen shall not be used as filler material in any electrical insulator. Materials having moisture absorption of 1.0 percent or less, and those used in hermetically sealed containers, need not be impregnated.

3.3.1.1.7.8 Varnish, Insulating. Insulating varnish shall conform to MIL-I-24092.

3.3.1.1.8 Lubricants. Lubricants used in equipment shall be suitable for the purpose intended.

3.3.1.1.8.1 Volatility. Low volatility lubricants shall be used.

3.3.1.1.8.2 Compatibility. The lubricant shall be chemically inert with regard to the materials it contacts.

3.3.1.1.8.3 Silicones. Silicone compounds shall not be used as lubricants.

3.3.1.1.8.4 Graphite Base Lubricants. Graphite base lubricants shall not be used.

3.3.1.1.9 Rubber (natural). Natural rubber shall not be used.

3.3.1.1.10 Wood and Wood Products. Wood and wood products shall not be used inside equipment.

3.3.1.1.11 Thread Locking and Retaining Compounds. Thread locking and retaining compounds shall conform to MIL-S-22473 or MIL-S-46163 and shall be applied in such a manner that the required level of locking or retaining is achieved and maintained. Such compounds shall:

a. not be used where required electrical conductivity is impaired.

b. not be used where failure of the compound would endanger personnel or damage the equipment.

c. be compatible with the material and finish to which they are bonded and shall have no detrimental effect on the material or finish.

d. not cause or accelerate corrosion.

3.3.1.1.12 Antiseize Compounds. Antiseize compounds shall conform to MIL-T-22361 or TT-S-1732. Graphite base antiseize compounds shall not be used.

3.3.1.2 Processes. The fabrication method or process shall be appropriate for the intended use of the part.

3.3.1.2.1 Brazing. Brazing shall be in accordance with MIL-B-007883. Electrical connections shall not be brazed.

3.3.1.2.2 Castings. The type of casting used shall be appropriate to the application of the part.

3.3.1.2.2.1 Die Castings. Zinc alloy die castings shall not be used where dimensional changes of the casting could affect use of equipment.

3.3.1.2.2.2 Inserts. Inserts which are intended to be cast in place shall be knurled, grooved, or otherwise prepared to secure satisfactory keying of the insert to the casting. Inserts shall be fabricated from a material which is not adversely affected by exposure to the molten casting alloy. When inserts are located near a casting edge, sufficient edge distance shall be allowed in order to develop the required resistance to insert pull-out, and to avoid cracking of the casting. Casting defects resulting from use of inserts, such as partial alloying, poor bonds, porosity, and cracks shall not be present.

3.3.1.2.2.3 Porous Castings. When used, castings shall be impregnated in accordance with MIL-STD-276.

3.3.1.2.2.4 Classification and Inspection. Castings shall be classified and inspected in accordance with MIL-STD-2175.

3.3.1.2.3 Encapsulation and Embedment (potting). The encapsulation and embedment materials shall be selected on the basis of the item(s) being encased. The manufacturer's instructions for mixing, method of application, and curing shall be followed. The materials shall be capable of filling all voids and air spaces in and around the item(s) being encased.

3.3.1.2.3.1 Materials. Materials shall be of a nonreversion type. Materials used for encapsulation and embedment of parts and assemblies shall be in accordance with applicable design requirements. Such materials shall have no deleterious effect on the part or assembly to which they are applied. The materials shall be contained, if necessary, to prevent flow or cracks under the specified storage or operating environment.

3.3.1.2.3.2 Application. No encapsulation or embedment materials shall be applied to an individual part except as part of the controlled production process for that part. The encapsulation or embedment of microelectronic modules and equipment modules shall be avoided, except where specifically indicated by the requirements of a particular application. In such instances, the module design shall be completely verified for the particular encapsulation or embedment materials and processes to be employed. Any changes in module design, materials, and processes will require re-evaluation of the modules. In particular, extreme temperature aging and temperature cycling tests shall be performed to verify adequacy of the design. Wherever economically feasible, the module to be encapsulated or embedded shall be designed as a throw-away unit.

3.3.1.2.4 Welding, Structural. The joint areas of all parts to be welded shall be cleaned of contaminants and materials which may be detrimental to obtaining satisfactory welds. The fusion, penetration, and size of the weld shall be sufficient to meet the design requirements. Degradation of material properties in the heat affected zone caused by welding shall be considered. Weldments shall be stress relieved when induced stress resulting from welding, design configuration, or materials welded may be harmful. (See AWS A2.4 for welding symbols, AWS A3.0 for welding terms and definitions, and MIL-STD-22 for welded joint designs.)

3.3.1.2.4.1 Arc and Gas Welding. Welding by arc and gas methods shall be performed by operators who have passed the applicable certification tests and have a certificate of proficiency in accordance with MIL-STD-248 or MIL-STD-1595. Electrodes used in arc welding shall be of the type that will produce a weld having chemical and physical properties similar to those of the parent metal. For the materials indicated, welding shall conform to MIL-STD-2219.

3.3.1.2.4.2 Resistance Welding. Where structural spot welding is used, the number of welds shall be sufficient to provide adequate strength for the intended purpose with no less than two welds on each part. Spot welding of joints shall conform to the process requirements of MIL-W-6858.

NOTE: MIL-HDBK-5 shall be used as a guide for spot-to-sheet edge distances and allowable strengths.

3.3.1.2.4.3 Noncritical Applications. For those applications, if the weld should fail, and it will not compromise personnel or equipment safety or prevent completion of the mission, then welding procedures in accordance with MIL-STD-1261 may be used.

3.3.1.2.4.4 Other Methods. Other welding methods, such as the electron beam process (MIL-W-46132), may be used provided approval is obtained from FAA.

3.3.1.2.5 Welding, Electrical and Electronic Interconnections. Electrical interconnection resistance welds shall be in accordance with MIL-W-8939.

3.3.1.2.5.1 Electrical Connections. Except where needed to meet electromagnetic interference or system compatibility requirements, welded electrical connections shall not be used where it may be necessary to disconnect, replace, or reconnect a part or module during servicing.

3.3.1.2.5.2 Excess Conductor Wire. Excess conductor wire shall be trimmed sufficiently close to provide adequate clearance and prevent possible electrical shorting but not so close as to cause damage to the weld joint.

3.3.1.2.5.3 Strain Relief. Each part lead terminating at a connection point shall have allowance for strain relief to minimize tensile or shear stress.

3.3.1.2.6 Equipment Finish. For equipment that is to be operated within a facility, the surfaces shall be given a protective finish as specified in the following subparagraphs:

3.3.1.2.6.1 Painted Finish. Metal surfaces not otherwise protected as described herein shall be painted. The painted surfaces must be able to withstand the environmental conditions defined by the equipment specification. Selection of color and surface finish must also be defined in the equipment specification. Leaded paint or paints containing isocynates and hazardous substances shall not be used to protect metal surfaces.

3.3.1.2.6.2 Aluminum Surfaces. The surfaces of aluminum and aluminum alloy shall be treated to protect the surface from finger-marks using either chemical film treatment (in accordance with MIL-C-5541) or anodizing. Masking of aluminum and aluminum alloy or other means shall be employed to insure low-resistance contact .

3.3.1.2.6.3 Finishes. Where electroplating is employed as a finish, it shall be equal to the best commercial grade, using finish thickness adequate for protection of the parts under conditions of their use in service. Flash finishing, finishing with base metals or underplatings showing through, or finishing which are pitted or give evidence of flaking or peeling, are not acceptable. The type of finishing which shall be used on specified base metals are as follows:

Base Metal	Finishing Requirements
Monel	Smooth finish free from discoloration.
Stainless steel	Passivation treatment after machining; smooth finish free from discoloration
Ferrous metal	Exterior hardware; bright chromium over nickel copper Interior hardware; zinc, or white chromium over nickel and copper, or white or bright cadmium.

Copper, Brasses, Bronzes	Exterior hardware; bright nickel or chromium. Interior hardware; white or bright nickel or chromium. Other parts; white or bright nickel, chromium, tin or cadmium.

3.3.1.2.6.3.1 Cadmium Plating. Cadmium plating shall not be used if it is in direct contact with, or located in confined spaces adjacent to waxes, phenolics, or other organic materials which will react with the cadmium to cause growth or the formation of cadmium soaps. Cadmium plating shall not be used if the paint is subjected to wear from friction. Cadmium plating shall be in accordance with Type II, Class 1 of QQ-P-416 plating with the following exceptions:

a. Bolts, studs, washers, nuts, and articles with portions externally threaded. These parts have a minimum of class 3 thickness.

b. Parts whose dimensional tolerances will not permit a class 2 thickness shall be given the maximum thickness of plating compatible with dimensional tolerances.

c. Holes, recesses, internal threads, and other areas where a controlled deposit cannot be obtained normally shall not be subject to a thickness requirement.

d. Corrosion-resistant internal-threaded inserts, or protective antiseize compounds, or internal threads, shall be used where necessary in cadmium-plated parts.

3.3.1.2.6.3.2 Zinc and Zinc-Plated Parts. Zinc and zinc-plated parts shall be given a dichromate treatment in accordance with ASTM-B633.

3.3.1.2.6.3.3 RF Conductivity Platings. Silver electroplating may be used where required because of the considerations of conductivity. Silver plating shall be in accordance with QQ-S-365, with a minimum thickness of 0.0005 inch.

3.3.1.2.6.3.4 Tin Plating. Tin plating shall be in accordance with MIL-T-10727.

3.3.1.2.6.4 Corrosion-resisting Treatments. Corrosion-resisting treatments shall be applied after all fabricating operations (such as welding and machining), have been completed. The corrosion-resisting treatments and metallic coatings shall be in accordance with the applicable portions of MIL-S-5002.

3.3.1.2.6.5 Masking. Masking or equivalent means shall be employed where necessary to insure continuity of electrical contact with metallic mounting surfaces, chassis, parts, etc., assembled against the back surface of the panel or panel door.

3.3.1.2.7 Wire Wrapped Solderless Connections. Backplane solderless wrapped wire connections shall be in accordance with MIL-STD-1130. FAA approval is required for specific design use.

3.3.1.3 Parts.

a. For unmodified COTS and NDI equipment, parts are not required to comply with the criteria stated herein but the degree to which they do comply may be used to differentiate among competing equipments.

b. For developmental items, standard parts defined herein may be used without further government approval. The use of alternative parts which are not defined herein but which offer better value to the government is encouraged even though such parts might require non-standard parts approval.

3.3.1.3.1 Application, Use and Orientation of Parts. Application and use of parts shall be in accordance with the respective requirements of this specification and the equipment specification, SOW, and RFP. However, if such specifications do not cover use and applications for a given part, the manufacturer's recommendations shall be followed. When the equipment is in its normal operating position, parts shall be oriented in accordance with the equipment specifications or manufacturer's recommendations. In the absence of any data covering the intended application, use and orientation shall be consistent with valid engineering considerations, including operating and reliability requirements.

3.3.1.3.1.1 Standard Parts. Standard parts do not need FAA approval prior to use. Parts which meet at least one of the following requirements shall be considered standard.

a. The part is specified in this specification, by part number in the equipment specification or statement of work.

b. The part is called out in a military standard or specification referenced in this specification, the equipment specification, or the statement of work.

c. The part is called out in a federal standard or specification referenced in this specification, the equipment specification, or the statement of work.

d. The part is called out in an industry standard referenced in this specification, the equipment specification, or the statement of work.

A standard part shall also be a part specified in the above as of date (or later) of the contract, Request for Proposal (RFP), Request for Bid (RFB), etc.

3.3.1.3.1.2 Nonstandard Parts. Nonstandard parts require government approval under procedures given in Appendix IV prior to adoption by the contractor for design and use in the equipment. All requests for approval of nonstandard items shall be submitted by the contractor to the Contracting Officer in accordance with Appendix IV.

3.3.1.3.1.3 Electrostatic Discharge. An Electrostatic Discharge Control Program shall be implemented and maintained in accordance with MIL-STD-1686.

3.3.1.3.1.4 Contractor's Responsibility. Parts selected in accordance with this specification or the equipment specification shall not relieve the contractor of his responsibility of complying with the equipment performance requirements and the other requirements of the equipment specification.

3.3.1.3.1.5 Program Parts Selection List (PPSL). Parts meeting the requirements of Paragraph 3.3.1.3.1.1 shall be entered on the PPSL by the contractor. Defense Electronics Supply Center/Defense Industrial Supply Center (DESC/DISC) approval is not required for these items. However, DESC/DISC may comment on the correctness of the information presented in accordance with Appendix IV, Paragraph 40.2.

3.3.1.3.1.6 Nonstandard Mechanical Parts. Parts constructed of standard or approved materials with appropriate standard or approved finishes do not require nonstandard part approval. Drilling, punching, bending, forming or otherwise affecting a mechanical part by applying standard or approved processes does create new part numbers or identities, but such parts need not be submitted for approval or added to the PPSL.

3.3.1.3.2 Derating Policy and Design Tolerance Values.

3.3.1.3.2.1 Electronic Part Derating Policy. In the application of electronic parts, the parts selected shall be used within their electrical ratings and environmental capabilities (e.g., any ambient or hot spot temperatures, voltage, current, or power dissipation). Derating shall be accomplished as necessary to assure the required equipment reliability within the specified operating conditions.

3.3.1.3.2.2 Design Tolerance (end-of-life) Values. In designing circuitry for long term performance, consideration shall be given to part parameter drift. The circuits shall be designed to perform their intended function accommodating this long term parameter drift.

3.3.1.3.3 Bonding, Securing, and Fastening Methods. Structural bonding and assembly of the equipment, including assembly of structures, panels, subpanels, chassis, subchassis, brackets, mechanical and electrical parts, subassemblies, mounting devices, guides and retainers for parts and for subassemblies, such as resistor boards, printed wiring boards and cards, shall be accomplished exclusively by means of processes, securing methods, fasteners, and other devices, that are specifically called out in this specification. Other types of bonding, securing, and fastening shall not be used without FAA approval.

3.3.1.3.4 Electrical Parts.

3.3.1.3.4.1 Batteries. Batteries shall not be used unless specifically required by the equipment specification, and shall be in accordance with the following. Battery backup power systems shall use Type IV, deep discharge cycle motive, Class 3, sealed, no-maintenance batteries (FAA Order 6980.24, Battery Theory and Selection Guidelines). The batteries shall be of suitable rating and capacity to supply and maintain the total load for a period of 4 hours minimum at the lowest operating temperature (FAA Order 6950.2, Electrical Power Policy Implementation at NAS Facilities), without the voltage applied to the load falling below 87.5% of specified normal voltage.

3.3.1.3.4.1.1 Battery Compartment. The battery compartment shall be provided with devices to firmly secure the batteries. Adequate room shall be provided for battery installation, maintenance, testing, and removal without disassembly of the equipment. The battery compartment shall prevent pressure buildup from heat, gasses, liquids, or chemicals released during battery operation, charging, deterioration, or rupture, and shall also prevent such materials from entering the electronic compartment.

3.3.1.3.4.1.2 Magnesium Dry Batteries. When magnesium dry batteries are used, extra precautions shall be observed because these batteries give off heat at high rates of discharge (less than 10 hours) and emit hydrogen. The surrounding area must be vented.

3.3.1.3.4.1.3 Lithium Batteries. Lithium batteries shall comply with the requirements of UL 1642. When lithium batteries are considered for use in an equipment, guidance on their use, transportation, storage, and disposal should be requested through the FAA from the following sources:

US Army Laboratory Command,
ATTN: SLCET-P,
Ft Monmouth, NJ 07703-5302

Department of the Navy
Naval Sea Systems Command

ATTN: NAVSEA 652
Washington, DC 20362

Air Force Wright Aeronautical Laboratories
ATTN: POOC,
Wright Patterson AFB, OH 45433

3.3.1.3.4.1.4 Installation Marking. Connections, polarity, minimum acceptable voltage for equipment operation, nominal voltage, and type(s) of batteries required shall be marked as applicable in a prominent place on or adjacent to the battery compartment.

3.3.1.3.4.1.5 Warning Label. Except for equipment requiring permanent battery installation, battery-powered equipment shall be labeled externally as follows:

WARNING

REMOVE BATTERIES BEFORE

SHIPMENT OR INACTIVE STORAGE

OF 30 DAYS OR MORE

3.3.1.3.4.2 Capacitors. Capacitors shall be in accordance with the following:

3.3.1.3.4.2.1 Selection. Capacitors shall be selected and applied in accordance with MIL-STD-198. Established reliability (ER) parts shall be used. Minimum level shall be failure rate R.

3.3.1.3.4.2.2 Variable, Compression Type. Compression (spring plate) type variable capacitors shall not be used.

3.3.1.3.4.2.3 Fixed, Tantalum Electrolytic. Tantalum capacitors shall be tantalum cased units in accordance with MIL-C-39003, MIL-C-39006, MIL-C-39006/22 or MIL-C-39006/25.

3.3.1.3.4.2.4 Fixed, Aluminum Electrolytic. Fixed, dry electrolytic (aluminum oxide) capacitors shall conform to MIL-C-39018 and shall be used only where capacitance values and other associated characteristics are not available in MIL-C-19978, MIL-C-39003, MIL-C-39006, MIL-C-39006/22 or MIL-C-39006/25.

3.3.1.3.4.2.5 Fixed, Paper Dielectric. Paper, paper-plastic, and metallized paper capacitors in molded cases shall not be used, except that nonmetallic-plastic wrapped capacitors in accordance with MIL-C-55514 may be used in encapsulated or hermetically sealed assemblies.

3.3.1.3.4.3 Circuit Breakers. Circuit breakers shall be in accordance with the following:

3.3.1.3.4.3.1 Selection and Application. Circuit breakers shall be selected from MIL-STD-1498. Circuit breakers conforming to W-C-375 may be used where commercial power sources are utilized. Trip-free circuit breakers shall be used unless otherwise specified or approved by the government program office. Non-trip-free circuit breakers shall be used only when the application requires overriding of the tripping mechanism for emergency use. Circuit breakers shall be compatible with the currents encountered.

3.3.1.3.4.3.2 Manual Operation. Circuit breakers shall be capable of being manually operated to the ON and OFF positions. Circuit breakers shall not be used as ON/OFF switches unless they have been specially designed and tested for that type of service.

3.3.1.3.4.3.3 Internal Access. Access to the internal mechanism of a circuit breaker shall require the breaking of a seal.

3.3.1.3.4.3.4 Position Identification. Circuit breakers shall have easily identified ON, OFF and TRIPPED positions except that the TRIPPED position may be the same as the OFF position with no differentiation between OFF and TRIPPED being required.

3.3.1.3.4.3.5 Orientation. Circuit breakers shall operate when permanently inclined in any direction up to 30 degrees from the normal vertical or normal horizontal position. The rated point of an inclined unit shall not vary more than ± 5 percent of the current specified for normal position mounting. Circuit breakers used on portable test equipment shall operate within the limits of the detail specification when the equipment is in any position or rotation about its three principal axes.

3.3.1.3.4.3.6 Vertical Mounting. Vertically mounted circuit breakers with toggle handle actuators shall have the ON position upward.

3.3.1.3.4.3.7 Insulating Materials. Insulating materials used in the construction of circuit breakers shall neither support combustion nor give off noxious gases when subjected to the electrical arcing found in circuit breakers. Insulating materials subjected to arcing on instantaneous high current tripping shall be nontracking when subjected to the specified current limit.

3.3.1.3.4.3.8 Reserved.

3.3.1.3.4.3.9 Location. When circuit breakers are an integral part of the equipment, the circuit breakers shall be located on the equipment front panel. Other locations require FAA approval.

3.3.1.3.4.3.10 Dielectric Withstanding Voltage. The dielectric withstanding voltage shall not be less than 1,000 volts plus twice the nominal operating voltage.

3.3.1.3.4.3.11 Insulation Resistance. Unless otherwise specified, insulation resistance shall be 100 megohms or more.

3.3.1.3.4.4 Crystal Units, Quartz. Quartz crystal units shall be selected in accordance with MIL-STD-683. Crystal oscillator units shall conform to MIL-O-55310.

3.3.1.3.4.5 Frequency Synthesizers. Frequency synthesizers adjustable throughout the range of the transmitted carrier frequency shall be used instead of crystals unless the range is a single frequency or the use of a crystal is approved by the FAA.

3.3.1.3.4.6 Delay Lines. Passive delay lines shall be in accordance with MIL-D-83531.

3.3.1.3.4.7 Electrical Connectors. Electrical connectors shall be in accordance with the following:

3.3.1.3.4.7.1 Selection. Selection and use of electrical connectors shall be in accordance with MIL-STD-1353 and as specified herein. Intended use information contained in the individual connector specifications shall be considered prior to making connector selections. Contact crimp, installing, and removal tools shall be in accordance with MIL-STD-1646 or as specified in the individual connector specifications. However, contractors may use tooling as recommended by the contact or tooling manufacturer provided that the finished crimp meets all of the performance requirements of the contact and connector specification. The variety of these tools required within a system shall be kept to a minimum. Maintenance instructions and other data supplied by the contractor shall list the military standard tools and contacts.

3.3.1.3.4.7.2 Audio-frequency and Communication Connectors. Special purpose connectors conforming to MIL-C-10544 or MIL-C-55116 shall be used in audio frequency applications, such as head sets and chest sets excluding pilots' helmets. Connectors conforming to appropriate ANSI standards may be used for low level, three wire and audio input circuits in fixed plant noncritical sound equipment.

3.3.1.3.4.7.3 Connectors with Thermocouple Contacts. All connectors used in conjunction with thermocouples shall have their contact materials identified by one of the following methods:

a. Nameplate securely attached to each connector half or mounted on the panel mounted receptacles.

b. By means of insulation sleeving or other markers designed for attachment around wire bundles. Markers shall be attached adjacent to the plug. Contact materials shall be identified with abbreviations in accordance with Table VIII.

TABLE VIII. ABBREVIATIONS FOR THERMOCOUPLE MATERIALS

Chromium	CR
Cobalt	CO
Alumel	AL
Tungsten Rhenium	W RE
Iron	FE
Tungsten	W
Constantan	CN
Iridium	IR
Copper	CU
Rhodium	RH
Platinum	PT
Iridium Rhodium	IR RH
Platinum Rhodium	PT RH
Molybdenum	MO
Rhenium	RE
Gold	AU

3.3.1.3.4.7.4 Power Connectors (40-200 amperes). All power connectors shall conform to Section 102 of MIL-STD-1353. Connectors used shall be in accordance with the requirements of Class L. The connectors shall be used with heavy duty jacketed cable as specified on the insert standards.

3.3.1.3.4.7.5 Heavy Duty Connectors. Connectors for general purpose heavy duty applications and power applications shall conform to Section 102 of MIL-STD-1353. Connectors used for external applications shall be pressurized and waterproof in the mated and unmated condition in accordance with the requirements of Classes C or L. Connectors used internally (within a protective enclosure such as a shelter) may be in accordance with Class R provided waterproofing or pressurization is not a requirement for the application. In applications where a right angle bend is required, center lock screw multicontact connectors shall conform to MIL-C-12520 and MIL-C-55181, where practical.

3.3.1.3.4.7.6 Connectors, General Utility. Polarized connectors are required and shall be used where automatic grounding must be provided to ensure safety to equipment and personnel. Connectors for general utility power applications shall conform to Section 106 of MIL-STD-1353. Also see Paragraph 3.1.2.2.4.

3.3.1.3.4.7.7 Plugs and Jacks (telephone type). Telephone type jacks and plugs shall be in conformance with the following:

3.3.1.3.4.7.7.1 Bantam Type Plugs and Jacks. Bantam type plugs and jacks shall conform to MIL-P-642 and MIL-J-641.

3.3.1.3.4.7.7.2 Modular Type Plugs and Jacks. Modular type plugs and jacks shall conform to the specifications of Federal Communications Commission Part 68, Subpart F, Paragraph 68.500. Applications and configurations shall be in accordance with those of Exchange Carriers Standards Association (ECSA) Technical Report No. 5 (Technical Report on Carrier to Customer Installation Interface Connector Wiring Configuration Catalog).

3.3.1.3.4.7.8 Test Jacks. Test jacks shall conform to Section 105 of MIL-STD-1353.

3.3.1.3.4.7.9 Radio Frequency (RF) Connectors. RF connectors as well as RF test points shall conform to Section 200 of MIL-STD-1353. Adapters used with RF connectors shall conform to MIL-A-55339.

3.3.1.3.4.7.10 Printed Assembly Connectors. Printed assembly connectors shall conform to Section 104 of MIL-STD-1353.

3.3.1.3.4.7.11 Protective Measures. All unmated connectors shall be protected with metal or plastic caps or otherwise suitably protected during maintenance, storage and shipment. Protective caps specified by military specifications or military standards and designed for mating with specific connectors shall be used. Unmated connectors which may contain electrically hot circuits while in environmentally hazardous areas shall be covered with moistureproof and vaporproof caps. Connectors on enclosed cabinet mounted equipment need not be provided with protective caps unless an environmental hazard exists.

3.3.1.3.4.7.12 Electrical Connector Potting. Potting materials shall conform to appropriate military specifications and shall not deteriorate in chemical, physical or electrical properties, under the specified system/equipment environment parameters.

3.3.1.3.4.7.13 Connectors for Flat Conductor Cable. Connectors for use with flexible flat conductor cable shall conform to MIL-C-83503.

3.3.1.3.4.7.14 Fireproof Connectors. Fireproof and firewall connectors shall be class K and shall conform to Section 101 of MIL-STD-1353. Where it is necessary to maintain electrical continuity for a limited time under continuous flame, both the receptacle and mating plug shall be class K. If flame integrity only is necessary without the need for electrical continuity, a class K receptacle shall be used, but the mating plug may be of any type and class. In all cases, the plug and receptacle shall be environment resisting.

3.3.1.3.4.7.15 Receptacles and Cords. The AC line receptacles and power cords shall be in accordance with Paragraph 3.1.2.2.4.

3.3.1.3.4.7.16 Accessories. Connector accessories shall be compatible with the connector and cabling used.

3.3.1.3.4.7.17 Extra contacts. The following requirements are applicable to all articles of equipment, except power connectors, and items such as dynamotors, inverters, indicating instrument (meters), encapsulated assemblies, and printed assemblies in which it is unlikely that additional circuits will be required. This requirement shall not apply when the connector is defined by a Federal standard.

a. Quantity and location. Unused connector contacts or contact positions for external circuits shall be available for future use, and shall be located on the periphery (outer contacts) of the connector. The minimum quantity shall be as specified below:

Total number of used contacts in connector	Unused contacts or contact positions required (min)
1 thru 25	2
26 thru 100	4
101 or over	6

b. An extra connector shall not be used to meet this requirement without the approval of the procuring activity.

c. Size and rating of extra contacts. The size and rating of extra contacts shall be compatible with other contacts within the connector.

d. Crimp contact connectors. All contact positions shall be filled when environmentally sealed connectors are used.

e. Sealing plugs. Sealing plugs shall be inserted in the grommet holes of unused contacts in environmentally sealed connectors.

f. Potted connectors. For potted connectors, each unused contact shall have a maximum gauge wire of 6 inches minimum length attached and identified with the contact designation for future use. For connectors external to the unit, the wire end shall be suitably capped to prevent moisture from entering the connector.

3.3.1.3.4.8 Filters, Electrical. Analog electrical filters shall be selected and used in accordance with MIL-STD-1395, with the following additional requirements:

3.3.1.3.4.8.1 Nonstandard. MIL-F-18327 nonstandard cases and mountings, designated YY and ZZ shall not be used. The temperature class shall be limited to R, S, and V. The life expectancy shall be limited to X.

3.3.1.3.4.8.2 Temperature. The operating temperature range shall be limited to B and C of MIL-F-15733.

3.3.1.3.4.9 Fuses, Fuseholders, and Associated Hardware.

3.3.1.3.4.9.1 Selection. Fuses, fuseholders, and associated hardware shall be selected from MIL-STD-1360. Fusing shall be arranged so that fuses in branch circuits will open before the fuses in the main circuit. Fuses are not intended to perform the function of thermal overload relays or circuit breaker devices. Fuses shall have ratings which correspond to those of the parts and wiring they protect. Fuse ratings shall be compatible with both starting and operating currents. All fuses shall be easily replaceable. Connections to extractor post type fuse holders shall be such that the load is connected to the fuse terminal which terminates in the removable cap assembly.

3.3.1.3.4.9.2 Extraction. Fuseholders shall be the extractor type and shall be mounted on the front panel, readily replaceable and in a convenient, serviceable location. Indicating type fuseholders are mandatory for fuses used in AC line circuits (120V to 240V nominal design values). (See Paragraph 3.1.2.2.5.c.)

3.3.1.3.4.10 Indicator Lights. The indicator lights shall be flange or bayonet types conforming to MIL-L-3661. Selection of colors for indicator light lens shall be in accordance with Paragraphs 3.3.7 and 3.3.7.4 - 3.3.7.4.5 Indicator lights shall not be connected in series. LED's, when used as indicator lights, shall conform to MIL-S-19500.

3.3.1.3.4.11 Analog Meters, Electrical Indicating. Meters shall be panel type electrical indicating instruments in accordance with ANSI Standard C39.1, or other styles in accordance with MIL-STD-1279, and as follows:

3.3.1.3.4.11.1 Size. The size for meters shall be 2 1/2 or 3 1/2 inches nominal. For time measurement, 1 inch meters are allowed.

3.3.1.3.4.11.2 Restriction. Rectifier meters shall not be used to indicate power line voltage or current nor filament/heater voltage or current.

3.3.1.3.4.11.3 Radio Frequency (RF) Fields. Meters shall be suitably protected where they are physically located or electrically connected, because stray RF fields or currents developed within the equipment could cause damage to the meters or cause false indications.

3.3.1.3.4.11.4 Clearance. Clearance behind the panel shall be sufficient to accommodate replacement meters having the maximum depth behind panel allowed by ANSI C39.1 for the same basic size and type of meter.

3.3.1.3.4.11.5 Indicating Range. For analog meters, the normal operating value of the quantity to be indicated shall be between 1/3 and 3/4 of full scale deflection.

3.3.1.3.4.12 Meter Switching. Where meter switching is employed, the requirements in the following subparagraphs shall apply:

3.3.1.3.4.12.1 Power Supply. The power supply or other basic source of the electrical quantity being metered shall have an output voltage, at its greatest potential point, which shall not exceed 500 volts peak relative to ground, under all circumstances of parts failure and load removal.

3.3.1.3.4.12.2 Values. Meter indications shall be in terms of actual voltages or currents after appropriate multiplying factors have been applied to the meter indications.

3.3.1.3.4.12.3 Accuracy. Accuracy of indications at full-scale indication, after application of multiplying factors, shall be within (M ±2) percent of the actual voltage or current, where M is the percent-of-full-scale accuracy (rated, not actual) of the meter movement on its basic range (multipliers and shunts of meter switching circuit not connected to the meter terminals).

3.3.1.3.4.12.4 Limitation. Meter switching shall be limited, in the case of current-indicating meters, to meter movements requiring 1 milliampere or less for full-scale deflection.

3.3.1.3.4.13 Meter Shunts and Transformers. Meter shunts and transformers shall be in accordance with MIL-S-61 or MIL-I-1361.

3.3.1.3.4.14 Microelectronic Devices. Microelectronic devices shall be in accordance with the following subparagraphs.

3.3.1.3.4.14.1 Requirements. Microelectronic devices shall be selected in the order of precedence described herein. If the calculated system or item reliability designated by the equipment specification cannot be met by using lower level items, higher level parts shall be used. The highest level of precedence is subparagraph a. Subparagraphs b and c are the same level of precedence. Subparagraphs d through i require FAA approval.

Microcircuit Order of Precedence:

a. MIL-M-38510 JAN microcircuits, product assurance level class B minimum, listed in MIL-STD-1562, Table 1 and available on QPL or microcircuits produced in a MIL-I-38535 or ANSI/EIA-599 certified process flow.

b. MIL-M-38510 JAN microcircuits, listed in MIL-STD-1562, Tables II, III, IV, and V.

c. MIL-STD-454 requirement 64 for parts not covered in (a) and (b) above.

d. Active Standard Military Drawing (SMD) or DESC Selected Item Drawing microcircuits.

e. Vendor's part compliant to MIL-STD-883, Paragraph 1.2.1.

f. Vendor's part compliant to MIL-STD-883, Class B.

g. Vendor's part meeting temperature range -55 to +125 degrees C.

h. Vendor's part meeting temperature range -10 to +85 degrees C for Environment II equipment and 0 to +70 degrees C for Environment I.

i. Other microcircuits. See Appendix IV.

3.3.1.3.4.14.2 Non-Standard Devices. For devices selected from Paragraphs 3.3.1.3.4.14.1 d through h, the following information shall be included in the nonstandard part approval request (NPAR):

a. Device nomenclature, marking, configuration, functional requirements, parameters and limits sufficient to ensure the required form, functions and interchangeability.

b. Required environmental, endurance (life) and other design capability tests.

c. The applicable detail specification, SMD, or vendor/contractor document shall be specified for electrical performance, mechanical and final electrical test requirements.

d. Quality assurance requirements, including screening and lot quality conformance or acceptance tests. Devices shall be in accordance with MIL-STD 883, Paragraph 1.2.1.

3.3.1.3.4.14.3 Reliability. When required by the contract, reliability predictions for system/equipment design using microcircuit devices shall be prepared in accordance with Paragraph 3.2.3.4.

3.3.1.3.4.15 Motors, Dynamometers, Rotary Power Converters and Motor-Generators. Motors not capable of carrying locked-rotor current continuously when stalled, without permanent damage, shall be protected by use of fuses, circuit breakers, or manual reset thermal cutouts. Manual reset thermal cutouts shall be readily accessible for resetting. Multiphase motors shall be protected from damage which could occur as a result of loss of one phase of the power source.

3.3.1.3.4.16 Printed Wiring and Printed Wiring Boards.

3.3.1.3.4.16.1 Rigid Printed Wiring Boards. Rigid printed wiring boards for single-sided, double-sided, and multilayer construction shall conform to IPC-D-275 and IPC-RB-276. The materials for single-sided and double-sided printed wiring boards shall conform to IPC-L-115. The materials used for multilayer printed wiring boards shall conform to IPC-L-108 or IPC-L-109 as applicable.

3.3.1.3.4.16.2 Flexible Printed Wiring Boards. Flexible printed wiring boards shall conform to IPC-FC-250 or IPC-RF-245.

3.3.1.3.4.16.3 Printed Wiring Board Modification. Modifications to printed wiring boards i.e., the use of cuts and/or jumpers or any other changes are not authorized and are considered non-standard. Cuts and/or jumpers are defined in MIL-C-28809. Approval from the FAA contracting authority for each printed wiring board modification is required. All requests for approval for use of a printed wiring board modification shall be in accordance with FAA-STD-021, Appendix VIII. When the FAA contracting authority approves the non-standard printed wiring board, the printed wiring board modification being used shall be identified in the applicable documentation, such as design documentation, master drawing, printed wiring board assembly drawing, etc. The following information, per FAA-STD-021, Appendix VIII, shall be included in the request for approval for use of a printed wiring board modification:

a. Justification for the modification, i.e., a cut and/or jumper or any other change.

b. Environmental, endurance (life) and other design capability tests.

c. The applicable detail specification, SMD or vendor/contractor document shall be specified for electrical performance, mechanical and final electrical test requirements.

d. Quality assurance requirements, including screening and lot quality conformance or acceptance tests.

e. Plan for retrofitting of any/all printed wiring boards that may contain any modification, i.e., a cut and/or jumper or any other change.

f. Plan for any/all successful retesting of those tests that were performed prior to a modification.

3.3.1.3.4.16.4 Conformal Coating. Conformal coating shall be used only in accordance with the environmental conditions in Table III. When conformal coating is required, coating material shall conform to MIL-I-46058.

3.3.1.3.4.16.5 Terminal Boards and Terminal Junction Systems. Terminal boards, terminal junction systems, stud terminals, feed-through terminals, and binding posts shall be selected from MIL-STD-1277.

a. Terminal boards shall be secured only by bolts (machine screws) and shall be capable of ready removal and replacement. They shall be mounted in the position that will best facilitate the testing of the equipment.

b. The maximum number of lugs to be connected to any one terminal on a terminal board shall be as specified in the detail specification sheets for stud-type terminal boards. When not specified, the maximum shall be not more than four lugs to any one terminal of a board except that no more than two lugs are allowed for screw-type terminal boards conforming to MIL-T-55164. Accessories such as stud connectors, straddle plates, jumpers and terminal board lugs shall be counted as lugs for this purpose.

c. Adequate spacing or barriers shall be employed between adjacent stud or feedthrough terminals or binding posts to prevent corona discharge, breakdown, and low-leakage resistance under specified environmental conditions such as high humidity (including condensation) and high altitude for the particular application. Terminals shall not turn, loosen or deteriorate when the equipment is subjected to specified service conditions, such as shock and vibration. Terminals mounted on boards shall not cause cracking or delaminating of the board.

d. Installation of terminals shall be in accordance with Paragraph 3.2.2.1.

e. Terminal boards used in interconnecting units shall have 10 percent extra spare terminals, but in no case less than two.

3.3.1.3.4.17 Readout Devices. Incandescent type readout devices shall be in accordance with MIL-D-28803. Visible light emitting diode displays shall conform to MIL-D-87157, quality level B. Liquid Crystal Display (LCD) modules shall be in accordance with EIA-JESD-23.

3.3.1.3.4.18 Relays and Contactors. Relays and contactors shall be in accordance with the following:

3.3.1.3.4.18.1 Selection and Application. Relays shall be selected and applied in accordance with MIL-STD-1346 or selected from active DESC drawings.

3.3.1.3.4.18.2 Solid State Relays. Solid state relays shall be selected from MIL-STD-1346 or shall conform to MIL-R-28750.

3.3.1.3.4.18.3 Load Transfer Relays. Relays which are not specifically designed for load transfer applications shall not be used for this purpose.

3.3.1.3.4.19 Resistors and Thermistors. Resistors and thermistors shall be in accordance with MIL-STD-199, MIL-T-23648, or MIL-R-55342. Established reliability (ER) parts shall be used wherever possible. Minimum failure level shall be R.

3.3.1.3.4.20 Servo Devices. Servomotors, synchros, resolvers, tachometer generators, encoders, and transolvers shall be in accordance with the following:

3.3.1.3.4.20.1 Rotary Servo Devices. Rotary servo devices shall conform to MIL-S-81963.

3.3.1.3.4.20.2 Servomotors. Servomotors shall conform to MIL-S-22432 or MIL-S-22820 when the motor is coupled to a tachometer generator.

3.3.1.3.4.20.3 Synchros. Synchros shall be selected and applied in accordance with MIL-STD-710.

3.3.1.3.4.20.4 Resolvers. Resolvers shall be selected and applied in accordance with MIL-STD-1451.

3.3.1.3.4.20.5 Linear Resolvers. Linear resolvers shall conform to MIL-R-50781.

3.3.1.3.4.20.6 Tachometer Generators. Tachometer generators shall conform to MIL-T-22821 or to MIL-S-22820 when the tachometer generator is coupled to a servomotor.

3.3.1.3.4.20.7 Transolvers. Transolvers shall conform to MIL-T-83727.

3.3.1.3.4.20.8 Encoders. Encoders shall conform to MIL-E-85082 for general application. For altitude reporting applications, encoders shall conform to MIL-E-81512.

3.3.1.3.4.21 Semiconductor Devices. Semiconductor devices other than microcircuits shall be in accordance with the following:

3.3.1.3.4.21.1 Selection and Application. Semiconductor devices shall be selected in accordance with the following order of preference:

a. MIL-STD-701

b. MIL-S-19500

c. Active DESC drawings

3.3.1.3.4.21.2 Nonavailability. When these parts are not available, parts shall be specified/procured in accordance with the requirements of MIL-STD-750 or MIL-STD-1547.

3.3.1.3.4.21.2.1 Tests/screening. The devices selected shall be process conditioned, tested, and screened to the equivalent JANTX type semiconductor quality factor level. Critical usage applications specified by the equipment specification, shall be tested and screened to MIL-S-19500.

3.3.1.3.4.21.3 Hermetic Sealing. Semiconductor devices which are hermetically sealed in glass, metal, metal oxide, ceramic, or combinations of these materials shall be used.

3.3.1.3.4.22 Sockets and Accessories. Sockets and accessories for plug-in parts shall be in accordance with the following:

3.3.1.3.4.22.1 Sockets. Sockets for plug-in electronic parts shall be of the single unit type. They shall conform to MIL-S-12883 or MIL-S-83734. Sockets shall be used to mount microprocessors, memory devices, crystals and other programmable devices whose replacement may be anticipated as a consequence of a change(s) in system operational parameters during the system lifecycle. Use for other integrated circuits requires FAA approval.

3.3.1.3.4.22.2 Electromagnetic Shielding. Magnetically sensitive devices shall be shielded to control the effects of electromagnetic fields. Such devices shall be protected to ensure that their performance will not be degraded beyond equipment specification limits, by fields external to the equipment, nor produce emissions in excess of the specified operating limits per military or commercial specification as appropriate to the environment.

3.3.1.3.4.22.3 Clamps. Plug-in parts shall be securely retained in their sockets in their proper position under specified service conditions of shock and vibration. When a positive holding device is used, it shall be of the release type to allow replacement of the plug-in part.

3.3.1.3.4.22.4 Mounting Pads and Insulator Disks. Mounting pads and insulator disks required for use with small electrical or electronic devices shall conform to MIL-M-38527.

3.3.1.3.4.22.5 Part Socket Interfaces. The requirements of Paragraph 3.3.1.1.2 shall apply to part/socket interfaces defining dissimilar metals.

3.3.1.3.4.23 Switches. Switches shall be as follows:

3.3.1.3.4.23.1 Selection and Application. Switches and associated hardware shall be selected and applied in accordance with MIL-STD-1132. Switches required (other than those listed in MIL-STD-1132) shall conform to one of the following specifications; MIL-S-12285, MIL-S-15743, MIL-S-18396, MIL-S-21604, MIL-S-83731.

3.3.1.3.4.23.2 Interlock Switches. When interlock switches, are used, they shall be in accordance with MIL-S-8805/56.

3.3.1.3.4.23.3 Detent Action. Switches shall have a detent action to indicate activation. Exceptions are switches with momentary positions, an increase-decrease function, or those which are not manually operated.

3.3.1.3.4.23.4 Slide Switches. Slide switches shall not be used. NDI equipment incorporating slide switches shall require approval by the FAA.

3.3.1.3.4.24 Crimp Terminals. Crimp terminals shall be in accordance with the following:

3.3.1.3.4.24.1 Crimp Terminations. The applicable part specifications shall control the crimp termination.

3.3.1.3.4.24.2 Number of Wires Per Terminal Crimp. The total circular mil area of the terminated wires shall not exceed the circular mil area capacity of the crimp terminal.

3.3.1.3.4.24.3 Lug Terminals. Lug terminals shall be selected from MIL-STD-1277.

3.3.1.3.4.24.4 Crimping of Terminals. Crimping of terminals shall be accomplished so the connections will meet the resistance and tensile strength requirements and tests of MIL-T-7928.

3.3.1.3.4.24.5 Crimping Tools. Crimping tools shall be as specified in the individual terminal specifications. However, contractors may use tooling recommended by the terminal or tooling manufacturer provided the finished crimp meets all of the performance requirements of the terminal specification. Maintenance instructions and other data supplied by the contractor shall list the military standard tools, terminals and splices.

3.3.1.3.4.25 Transformers, Inductors, and Coils. Transformers, inductors, and coils shall be in accordance with the following:

3.3.1.3.4.25.1 Selection. Selection of transformers, inductors, and coils shall be in accordance with MIL-STD-1286 and the following subparagraphs:

3.3.1.3.4.25.2 Audio, Power, and High-power Pulse Transformers and Inductors. Audio, power, and high-power pulse transformers and inductors shall conform to MIL-T-27, grade 4, 5, or 6, and class Q, R, S, V, or T.

3.3.1.3.4.25.3 Intermediate, Radio Frequency and Discriminator Transformers. Intermediate, radio frequency and discriminator transformers shall conform to grade 1, 2, or 3, Class A minimum, of MIL-T-55631. The use of grade 3 transformers shall be limited to hermetically sealed or encapsulated assemblies.

3.3.1.3.4.25.4 Radio Frequency Coils. Radio frequency coils shall conform to grade 1, class O, A, B, or C of MIL-C-15305 except that radio frequency coils, fixed, molded, with established failure rate levels shall conform to MIL-C-39010, Class A, tolerance K, failure rate P, as a minimum.

3.3.1.3.4.25.5 Low-power Pulse Transformers. Low-power pulse transformers shall conform to MIL-T-21038, grade 4 or 5 and class Q, R, S, T or U.

3.3.1.3.4.25.6 Chip Inductors. Chip inductors shall conform to MIL-I-83446.

3.3.1.3.4.25.7 Variable Inductors. When a roller or slider is used in contact with the conductor of variable inductors, suitable provision shall be made to limit the travel of the roller or slider to prevent its leaving the conductor. The use of air wound coils for tuning shall be approved by the FAA. (Standard RF practices allow compressing and expanding of air-wound coils as being routine and necessary at higher frequencies.)

3.3.1.3.4.25.8 Variable Transformers. Variable transformers shall conform to MIL-T-83721, Class I or II.

3.3.1.3.4.25.9 Electrostatic Shield. All power transformers shall have an electrostatic shield.

3.3.1.3.4.26 Wiring. The selection, application, and wiring practices for cable and wire shall be in accordance with the following subparagraphs:

3.3.1.3.4.26.1 Clearance and Leakage (creepage) Distances. Clearance between solder connections or bare conductors (such as terminal strips, stand offs or similar connections), shall not allow accidental contact occurring between adjacent connections when subject to service conditions specified in the equipment specification. (For electrical clearance and leakage distances, see Table IX.)

TABLE IX. ELECTRICAL CLEARANCE AND LEAKAGE (CREEPAGE) DISTANCES

VOLTAGE AC (RMS) OR DC	CLEARANCE		LEAKAGE DISTANCE (inches)	
	CONDITION	INCHES	ENCLOSURE I	ENCLOSURE II
To 150	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	3/8	3/4
150-300	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	1/2	3/4
300-600	A	1/16	1/8	1/8
	B	1/8	1/4	1/4
	C	1/4	1/2	3/4
600-1000	A	1/8	1/8	1/2
	B	1/4	1/4	1
	C	1/2	1-1/2	2

Notes: 1. Condition A is for use where the effect of a short circuit is limited to the unit; and where normal operating power does not exceed 50-watts.

2. Condition B is for use where short circuit protection in the form of fuses, circuit breakers, etc, is provided; and where normal operating power does not exceed 2000 watts.

3. Condition C is for use where short circuit protection in the form of fuses, circuit breakers, etc, is provided; and where normal operating power exceeds 2000 watts.

4. Enclosure I is an equipment enclosure which has no openings or the openings are constructed so drops of liquid or solid particles striking the enclosure, at any angle from 0 degrees to 15 degrees from the vertical, cannot enter the enclosure directly or by striking and running along a horizontal or inwardly inclined surface.

5 Enclosure II is any equipment enclosure which provides less protection than Enclosure I.

3.3.1.3.4.26.2 Impedance Matching. Where cables requiring matched impedance are employed, equipment shall be designed to attain impedance matching with the cable and fittings.

3.3.1.3.4.26.3 Wiring Protection. The wiring shall be secured and protected against chafing due to vibration or movement (such as slide out racks or drawers). Wiring to pull-out drawers shall employ cable retractors to protect the equipment. For the securing of wiring, polyamide clamps or wrappings and tying devices with integral mounting facilities are preferred. Metal clamps, if used, shall be insulated.

3.3.1.3.4.26.4 Insulation Cold Flow. For insulated wire susceptible to cold flow, care shall be exercised so there will be no cold flow of the insulation.

3.3.1.3.4.26.5 Cable Ducts. Where cable ducts are employed, provisions shall be made for the removal of any wire that may become faulty. For example, covers may be employed at intervals to aid in the removal of a faulty wire.

3.3.1.3.4.26.6 Bend Radius. The bend radius of wire and cable shall not be less than five times the cable diameter to avoid establishing a permanent set in the cable.

3.3.1.3.4.26.7 Sleeving. Flexible plastic sleeving, either nonflammable, self extinguishing, or flame retardant, shall be used on cables subject to flexing, such as panel door cables. The sleeving shall be secured under cable clamps at each end. The cable shall be formed and secured so the cable will not be subject to abrasion in its normal flexing motion. In cases where abrasion cannot be avoided, additional protection shall be provided.

3.3.1.3.4.26.8 Panel Door Cables. Wiring to parts on a hinged door shall be contained in a single cable, arranged to flex without becoming damaged when the door is opened and closed. However, if physical separation between wires is essential for electrical reasons, or where the number of wires involved makes a single cable impracticable, more than one flexible hinging cable may be employed.

3.3.1.3.4.26.9 Through Hole Protection. Whenever wires are run through openings in metal partitions, shields, and the like, which are less than 1/8 inch in thickness, the holes shall be equipped with suitable mechanical protection (grommet) or insulation. Openings in panels 1/8 inch or more in thickness shall have either grommets or the edges of the openings rounded to a minimum radius of 1/16 inch. Grommets for wires operating at RF potentials exceeding 500 volts rms, shall be of ceramic or plastic material of suitable dielectric strength, except for coaxial cables which have outside protection, where rubber or neoprene is acceptable. Insulating grommets are not required for wires or groups of wires passing through shields or other metallic partitions where clearance can be maintained sufficiently to preclude the possibility of accidental contact or damage by abrasion.

3.3.1.3.4.26.10 Wiring Arrangement. All wiring shall be arranged in a neat and orderly manner. The use of preformed cables and wiring harnesses is preferred to the point-to-point method of wiring. Wires shall be bundled and routed to minimize electrical coupling. Where practicable, sensitive circuits in a wire bundle or cable shall not be placed adjacent to a distributing circuit. Materials used for lacing, binding, sleeving, and strapping shall be selected from appropriate government specifications, be compatible with the conductor or cable insulation or jacket, and shall meet the same flame retardant and self extinguishing requirements. Wiring shall be arranged to permit bundling or permanently mounted in cable ducts. Minimum tape size shall be in accordance with Table X.

TABLE X. MINIMUM TAPE SIZE

HARNESS DIAMETER (inches)	TAPE SIZE (width in inches)
Up to 1/2	.050
1/2 to 1	.085
1 to 2	.110
2 and larger	.200

3.3.1.3.4.26.11 Identification. Hookup wires in the equipment shall be distinctly coded in color or numbered in accordance with MIL-STD-681. Numbers shall not be used where they would be difficult to read or trace, such as in compact assemblies.

3.3.1.3.4.26.12 Slack. Discretely terminated wires and cables shall be as short as practicable, except that sufficient slack shall be provided to:

a. prevent undue stress on cable forms, wires and connections, including connections to resiliently support parts.

b. enable parts to be removed and replaced during servicing without disconnecting other parts.

c. facilitate field repair of broken or cut wires.

d. permit units in drawers and slide out racks to be pulled out to the limit of the slide and rotated (if rotatable) or support travel without breaking connections. Units which are difficult to connect when mounted, shall be capable of movement to a more convenient position for connecting and disconnecting cables. When drawers or racks are fully extended and rotated (if rotatable), the cable bend radius shall not be less than three times the cable assembly diameter. When flat molded cable assemblies are used, the bend radius shall not be less than ten times the cable assembly thickness.

e. permit replacement of at least two of the particular parts to which the wire or cable is connected. The only exceptions to this provision are cases where RF leads must be as short as possible for electrical reasons and when fixed path rotating is specified or the amount of slack is limited by space available as occurs in automatic machine wired panels and multi-pin connectors.

f. ensure freedom of motion of contacts or terminals normally intended to have some degree of movement (i.e., floating contacts in connectors).

3.3.1.3.4.26.13 Wiring in Terminal Boxes. Wiring and cables in terminal boxes shall be fanned out to identify terminals for check purposes if test points for required maintenance information are not provided.

3.3.1.3.4.26.14 Entrance Cabling and Wiring. Leads from cable entrances to terminal boards, plugs, jacks, and similar devices shall be harnessed and suitably clamped or supported in a cable duct. Flat cable may be used where suitable.

3.3.1.3.4.26.15 Wire. Stranded wire is preferred; however, solid wire may be used in the equipment, provided such wire is insulated and held in place so that it does not fail or show excessive motion likely to result in failure when the equipment is subjected to vibration and shock encountered under the specified service conditions. An uninterrupted wire is preferable to a junction. The following descending order of preference is: permanent splices, bolted connections, then connectors when junctions are used. The choice of the listed junctions shall be determined by consideration of reliability factors, maintenance factors, and manufacturing procedures.

3.3.1.3.4.26.16 Support. Wire and cable shall be properly supported and secured to prevent undue stress on the conductors and terminals and undue change in position of the wire or cable during and after subjection of the equipment to specified service conditions, or after service or repair of the equipment in a normal manner. When shielding on wire or cable is unprotected by an outer insulation, adequate support is necessary to prevent the shielding from coming in contact with exposed terminals or conductors. Twine or tape shall not be used for securing wire and cable.

3.3.1.3.4.26.17 Cable and Harness Design. Cables and separable harnesses shall be of the two-connector type whenever possible. The two connectors shall be of the same number of contacts and all contacts shall be wired point-to point (i.e., pin 1 to pin 1, pin A to pin A, or pin 1 to pin A and up in sequence). A minimum number of connector types and contact configuration within a type shall be used consistently with non-cross mating requirements, circuit and spare considerations.

3.3.1.3.4.26.18 Connectors, Insulation Sleeving. Unpotted connectors furnished as integral wired in parts of articles of equipment shall have a piece of insulating tubing placed over each wire in the connector. The tubing shall be long enough to cover the contact and have at least 1/2 inch of insulation of the wire attached to it; but in no case shall the length of the tubing exceed 2 inches. The minimum length of 1/2 inch may be reduced to 3/16 inch where restricted volume does not permit longer tubing (such as in miniaturized electronic subassemblies). The tubing shall fit tightly over the contact or be tied securely enough so that it will not slide off. If bare wire is used, the tubing shall be long enough to extend at least 1/4 inch beyond the contact, metal shell or clamp, whichever projects the furthest. This does not apply to connectors with body insulated crimp-on contacts, nor to wire wrapped connectors in accordance with MIL-STD-1130.

3.3.1.3.4.26.19 Fungus Protection. Prior to attachment of terminals to prepared lengths of cables containing materials that will support fungus, the ends shall be protected against entrance of moisture and fungus by treatment with a fungicidal varnish conforming to MIL-V-173 and in accordance with MIL-T-152.

3.3.1.3.4.26.20 Impedance. All interconnecting cables carrying RF signals shall make use of coaxial cable or waveguides and shall be terminated in the characteristic impedance of the transmitting media. The location and route of such signal cables shall be selected to preclude coupling to other conductors.

3.3.1.3.4.26.21 Aluminum Conductors. Aluminum conductors shall not be used.

3.3.1.3.4.26.22 Termination of Signal and Control Wiring. All signal and control wiring shall be terminated with a connector.

3.3.1.3.4.27 Fiber Optics. Use of fiber optics shall be in accordance with FAA-STD-049. (As of November 1993, this standard is in the FAA review cycle and should be approved by early 1994)

3.3.1.3.5 Mechanical Parts.

3.3.1.3.5.1 Bearings. Bearings shall be in accordance with the following subparagraphs:

3.3.1.3.5.1.1 Lubricant. Adequate lubricant shall be provided either within the bearing or externally in the form of oil reservoirs or grease relubrication facilities except as noted herein. Where lubricant

replenishment is required, precautions shall be taken to prevent purged or lost lubricant from entering and adversely affecting the operation of the equipment. Where bearings coated with preservative are installed in closed housings, the preservative shall be compatible with the lubricant used in the assembly. (See Paragraph 3.3.1.1.8)

3.3.1.3.5.1.2 Barrier Coating. Bearings requiring a barrier coating shall be coated in accordance with MIL-STD-1334. Barrier coating material shall conform to MIL-B-81744.

3.3.1.3.5.1.3 Seals and Shields. All rolling element bearings shall be adequately protected by seals or shields on the bearing or installed in housings which provide adequate shielding to prevent foreign matter from entering the bearing.

3.3.1.3.5.1.4 Self Lubricating Bearings. Permanently lubricated bearings or bushings of plastic, metallic-plastic combinations, or all metallic materials with or without dry film lubricants may be used provided wear products produced during operation will not cause or contribute to failure of the equipment or bearings.

3.3.1.3.5.1.5 Unlubricated Bearings. Unlubricated bearings or bushings may be used only in applications where the presence of a lubricant would be undesirable or detrimental and the functional, environmental and service life requirements can be met in this condition.

3.3.1.3.5.1.6 Electrical Grounding. Ball and roller bearings used for rotating an electrically energized equipment shall be electrically shunted to avoid current flow through the bearings.

3.3.1.3.5.1.7 Alignment. Bearings shall be located to ensure proper shaft alignment and support.

3.3.1.3.5.2 Controls. Controls shall be in accordance with the following section and shall comply with the human engineering criteria established in Paragraph 3.3.7. Controls shall conform to the general criteria including relationships between displays and controls, minimal complexity and precision required to accomplish the task, operator feedback, and appropriate illumination. See Appendix III of MIL-STD-1472 for tailoring.

3.3.1.3.5.2.1 Control Displays. All controls shall be marked, indexed, sized, and located in such a manner that the control position can be readily identified. Controls shall have fixed guide marks if presetting of the controls is required.

3.3.1.3.5.2.2 Arrangement and Location. Controls which function in sequential operation or which operate together shall be grouped together along with their associated displays. The arrangement of functionally similar or identical primary controls shall be consistent from panel to panel throughout the equipment. Controls shall be arranged to facilitate smooth and rapid operation. Controls located adjacent to their associated displays shall be so positioned that operation of the control will not obscure the display. Controls shall be sized and spaced so the manipulation of a given control does not interfere with the setting of an adjacent control. Adjustment controls with required test points shall be grouped and marked to provide for simplicity and ease of maintenance. When the activation of a given control is hazardous to the equipment or operator, safeguards shall be provided.

3.3.1.3.5.2.3 Coding. The use of a coding mode for a particular application shall be governed by the relative advantages and disadvantages of each type of coding. Where coding is to be used to differentiate among controls, applications of the code shall be uniform throughout the equipment. See MIL-STD-1472, Paragraph 5.4.1.4.

3.3.1.3.5.2.4 Direction of Movement. Controls shall be connected in the circuit so the controlled characteristics (e.g., sensitivity, volume, or voltage) increase with clockwise rotation of the control as seen from the operating position. Movement of a control forward, clockwise, right, or up, shall turn the equipment on, or cause the quantity to increase, the equipment to move forward, clockwise, to the right or up.

3.3.1.3.5.2.5 Operating Controls. Controls necessary for the operation of the equipment shall be readily accessible, and shall be located on the front panel of the unit.

3.3.1.3.5.2.6 Adjustment Controls. Adjustment controls that are required for periodic alignment or calibration shall be mounted behind covered openings (such as access doors), and on the faces of the equipment most accessible when installed. When not adjustable by hand, controls shall be designed to accept a common screwdriver blade tip. Controls which infrequently require adjustment need not be accessible from the operating panel, but shall be readily accessible for servicing when the equipment is opened for maintenance purposes. The adjustment range shall not be large enough to cause equipment damage.

3.3.1.3.5.2.7 Operation. Play and backlash in controls shall be held to a minimum commensurate with intended operational functions and shall not cause poor contact or inaccurate setting. Controls shall operate freely and smoothly without binding, scraping, or cutting. Controls may be lubricated when lubrication does not interfere with operation and is specified in the detail equipment specification. Normal settings of all continuously variable controls shall not fall in the first tenth or last tenth of angular rotation.

3.3.1.3.5.2.8 Stops. Mechanical stops shall be provided for all adjustable controls, except controls designed for unlimited rotation. Stops shall be provided on the driving end of the shaft where flexible control shafts are employed, or where stops that are integral to the adjustable control or the mechanism could be damaged by excessive torque.

3.3.1.3.5.2.9 Locking Devices. Control locking devices shall retain the controls in any given setting within the range of control. The locking and unlocking action shall be easily and quickly accomplished, and shall not affect the setting of the control. When in the unlocked position, the locking devices shall not interfere with the normal operation of the control. Where vernier controls are used, the locking devices shall operate on both main and vernier controls if necessary to prevent damage.

3.3.1.3.5.2.10 Non-turn Devices. All non-turning controls and bodies or cases of turning controls shall be equipped with a positive device to prevent their turning in the panel or in the assembly on which they are mounted.

3.3.1.3.5.2.11 Shafts and Couplings. Control shafts and couplings shall be of design and strength commensurate with their respective loads. Coupling between or to shafts shall be accomplished by means of metallic or insulated couplings rigidly secured. Shafts subject to removal may have their couplings secured by two set screws 90 to 120 degrees apart. Flexible couplings will be permitted for controls where the use of rigid couplings would interfere with the satisfactory operation or mounting of such controls. Flexible couplings shall not be employed for frequency determining circuits.

3.3.1.3.5.2.12 Control Knobs and Handles. Control knobs and handles shall have high impact strength and shall be firmly secured to the control shafts by use of set screws wherever that type of fastener is applicable. Plastic knobs and handles shall have metal inserts for set screws and shall not warp or crack.

3.3.1.3.5.2.13 Multiturn Counters Control Dials. Manually operated multiturn counter control dials shall conform to MIL-D-28728.

3.3.1.3.5.2.14 Construction. Switches, levers, and other controls which are manipulated during operation of the equipment shall be of rugged design and construction so they will not be damaged when repeatedly operated by unskilled personnel under the specified service conditions.

3.3.1.3.5.2.15 Switches.

3.3.1.3.5.2.15.1 Toggle Switches. Toggle switches should be used for functions which require two discrete positions or where space limitations are severe. Three or more position toggle switches are to be avoided, except where alternates, such as rotary, legend, etc. can not be used. Such factors as accidental activation, dimensions, resistance, displacement, separation, positive indication and orientation shall be considered in the layout of toggle switches.

3.3.1.3.5.2.15.2 Legend Switches. Legend switches shall conform to the requirements of MIL-STD-1472, Paragraph 5.4.3.1.5. Special attention shall be given to such issues as barrier height, size, positive indication, legibility, lamp reliability, and durability. No more than three lines of text shall be displayed. Lamps shall be replaceable from the front of the panel.

3.3.1.3.5.2.15.3 Rocker Switches. Rocker switches may be used in place of toggle switches for functions which require two discrete positions. The use of three position rocker switches shall be limited to those applications where no other switch type can be implemented due to space limitations, inadvertent actuation probabilities, or other factors. Such factors as illumination type, color coding, accidental activation, dimensions, resistance, displacement, separation, positive indication and orientation shall be considered in the layout of rocker switches. Vertical alignment is preferred. Placement of rocker switches shall conform to MIL-STD-1472, Figure 15.

3.3.1.3.5.3 Fastener Hardware. Fastener hardware shall be in accordance with the following subparagraphs:

3.3.1.3.5.3.1 General. Fasteners shall remain secure when exposed to equipment operational and environmental stresses. Except for those items designed to be affixed with one fastener, parts shall be secured so failure of a single fastener will not free the part completely. Friction between mating surfaces shall not be employed as the sole means of preventing fixed parts from rotating or shifting. For critically stressed applications, suitable torque values for screw thread assemblies shall be established and torque measuring or controlling devices shall be used for tightening the threaded parts.

3.3.1.3.5.3.2 Mounting and Assembly. The mounting or assembly of parts shall be accomplished by one of the following means except as required by Paragraph 3.1.3.4:

a. A through-screw secured by a self-locking nut or plain nut and lock washer. When frequent assembly/disassembly are anticipated (more than 15 times), a plain nut and lockwasher shall be used.

b. A through-screw secured by a plain nut, with a sealant applied to the threads of the screw and nut.

c. A screw into a threaded bushing (in a staked, clinched, pressed-in nut; or an insert). The bushing, nut, or insert shall be secured to the structure.

d. When an externally threaded fastener must be screwed into an aluminum alloy part and the parts must be frequently disassembled in service, the aluminum alloy parts shall be provided with inserts of corrosion-resistant steel or other suitable material. Threaded holes in plastic material, when used with externally threaded fasteners, shall be provided with suitable metallic inserts.

e. A screw in a tapped hole, with a sealant applied to the threads of the screw.

f. A stud in a tapped hole.

g. A self-locking screw in a tapped hole.

h. Self-tapping screw when used within the limitations of Paragraph 3.3.1.3.5.8.

3.3.1.3.5.3.3 Fastening of Brittle Materials. Brittle castings or parts made of ceramic or other brittle material shall be properly cushioned to prevent breakage. Washers or gaskets of suitable material and compressibility shall be used between the otherwise facing surfaces of the brittle part and other brittle or metal parts, to prevent breakage or damage to the protected parts during assembly or from severe shock, vibration or temperature changes encountered under the specified service conditions. Lead washers shall not be used.

3.3.1.3.5.3.4 Pliable Washers. Threaded devices securing parts mounted with pliable washers shall not depend upon lockwashers as a locking device. Threaded holes in ceramic material shall be avoided for assembly or mounting of parts.

3.3.1.3.5.3.5 Locking Devices. All threaded assemblies shall be vibration and shock proof. Fiber inserts shall not be used as locking devices. Castellated nuts with cotter pins are acceptable.

3.3.1.3.5.3.6 Stud-Mounted. Self-locking nuts shall be avoided on stud-mounted components unless the stud material is compatible with the strength or material of the nut used.

3.3.1.3.5.3.7 Application Without Nuts. In applications requiring the use of bolts or screws without nuts, one of the following locking devices or methods shall be used:

a. Lockwashers under the heads of the bolts or screws.

b. Self-locking screws.

c. Self-locking thread inserts.

d. A locking or retaining compound applied to the threads.

e. Safety wire through drilled heads.

3.3.1.3.5.3.8 Threaded Fasteners. Threads shall be in accordance with FED-STD-H28 or MIL-S-7742. Where threaded fasteners are required to mate with, or to mount threaded commercial equipment or devices, threads shall be in accordance with FED-STD-H28. Threads shall be in accordance with MIL-S-8879 for applications requiring high stress or high fatigue life. Caution shall be exercised where a MIL-S-8879 UNJ external thread fastener is used due to its incompatibility with the commonly used UNC, UNF, or UNEF threaded nut or tapped hole. The use of threaded fasteners made of aluminum alloy or magnesium to mate with threaded parts of aluminum alloy or magnesium shall be avoided. Where such is required, an antiseize compound shall be used to prevent seizing of the threads.

3.3.1.3.5.3.8.1 Thread Sizes. The following thread sizes shall be utilized to the maximum extent possible: Standard metric sizes are also allowed.

112-40 UNC	.2500-28 UNF	.5000-20 UNF
138-32 UNC	.3125-24 UNF	.5625-18 UNF
164-32 UNC	.3750-24 UNF	.6250-18 UNF
190-32 UNF	.4375-20 UNF	

3.3.1.3.5.3.8.2 Nuts. Sheet spring nuts shall not be used without specific approval of the FAA. Nuts shall be preferably of the hexagon style with the following exceptions:

a. Nuts used in conjunction with a mechanical means to prevent rotation, press-type nuts, i.e., gang channel nuts, floating and self-aligning plate nuts, clinch-type or press nuts.

b. Plate nuts of the lug style which are generally riveted or spot-welded to sheet structure.

c. Nuts designed for a specific purpose, e.g., nuts for honeycomb structure.

d.. Sheet spring nuts shall not be used without the specific approval of the FAA.

3.3.1.3.5.3.8.3 Self-locking Nuts. Self-locking nuts shall conform to MIL-N-25027. Self-locking nuts shall not use fiber inserts as the locking device.

3.3.1.3.5.3.8.4 Thread-forming, Thread-cutting, and Drive Screws. Thread-forming, thread-cutting, and drive screws shall not be used except as follows:

a. For use on equipment to be installed in a static (fixed station) environment for low-stress applications where disassemble is not required.

b. For the permanent attachment of nameplates to sheet metal where it is practicable to extrude the hole permitting a minimum 1/8-inch full-thread engagement.

c. For the permanent attachment of nameplates to material having nominal thickness of 1/8-inch or greater.

3.3.1.3.5.3.8.5 Thread Engagement. In highly stressed applications, screws or bolts shall have a minimum thread engagement of 1-1/2 times their nominal diameter in tapped parts other than nuts. In normal applications, screws or bolts shall have a minimum engagement length equal to their nominal diameter in tapped parts other than nuts. When the assembly is not frequently disassembled and where maximum strength is not required, less thread engagement may be used, provided special provisions are made to insure compliance with required conditions.

3.3.1.3.5.3.8.6 Lengths. The length of the screws and bolts installed with nuts shall be such that the exposed portion is a minimum of 1-1/2 threads. Maximum length shall be limited by the nearest larger standard screw length. These rules apply except when such projection will result in corona discharge or when design requirements can not be met.

3.3.1.3.5.3.9 Rivets. Rivets shall be used in preference to other hardware for securing parts not requiring removal when the equipment is serviced. Rivets shall not be used for mounting items normally subject to replacement, such as capacitors, resistors, transformers, or inductors. Wherever the thickness of metal which accepts the heads of flush rivets is less than the height of the rivet heads, the material shall be dimpled rather than countersunk. The distance from the center of rivet holes to the edges of the material in which rivets are placed shall not be less than 1-1/2 times the rivet diameter. Rivets for joining magnesium parts shall be composition 5056 anodized aluminum alloy or an aluminum allay having equal galvanic compatibility with the magnesium.

3.3.1.3.5.3.10 Other Hardware.

3.3.1.3.5.3.10.1 Inserts. Inserts shall be constructed so they will not loosen when tightening or loosening the screw or stud. External threaded inserts shall be capable of being replaced with inserts which have identical internal threads.

3.3.1.3.5.3.10.2 Flat Washers. Flat washers shall be used for the following applications:

a. Between screw heads and soft materials, unless a washer head screw, or similar type that provides a bearing surface equivalent to the bearing surface of the appropriate flat washer, is being used.

b. Between a nut or lockwasher and a soft material.

c. Where lockwashers are used for securing a soft material, a flat washer shall be provided to prevent marring or chipping of the material or the applied protective coating, except in areas where an electrical ground is required.

d. Except where it conflicts with electromagnetic interference considerations, a flat washer shall be used between an organically finished material and lock-washers, bolt and screw heads, or nuts.

3.3.1.3.5.3.10.3 Lockwashers. Preassembled nut and lockwasher or screw and lockwasher assemblies are considered satisfactory for use, provided they are replaceable by conventional nuts, screws, and lockwashers.

3.3.1.3.5.3.11 Materials and Finishes. All bolts, screws, nuts, and other fastener hardware shall be fabricated of corrosion-resistant metals or shall be cadmium plated in accordance with Paragraph 3.3.1.2.6.3.1, except that fasteners shall not be subject to embrittlement relief test. Tin plating in accordance with Paragraph 3.3.1.2.6.3.4 may be used in lieu of cadmium plating if soldering to the part is required. Standard MS or AN parts with other suitable finishes do not require refinishing.

3.3.1.3.5.3.11.1 Dry Film Lubrication. For dry-film lubricated nuts, the type and class of plating are optional if the nuts conform to the salt spray requirements for type II plating in accordance with QQ-P-416.

3.3.1.3.5.3.12 Safety Wiring and Cotter Pins. Application of safety wiring and cotter pins shall conform to MS33540. Safety wiring and cotter pins shall not be used on terminals such as screws and threaded studs required to function as electrical terminals.

3.3.1.3.5.4 Gears and Cams.

3.3.1.3.5.4.1 Design. The design of a gear train shall be such that the gear train system shall meet performance requirements throughout its specified life.

3.3.1.3.5.4.2 Criteria. Gears shall be designated, dimensioned, toleranced and inspected in accordance with American Gear Manufacturers Association (AGMA) specifications.

3.3.1.3.5.4.3 Preferred Gearing. Planetary or epicyclic gearing is preferred to worm gearing.

3.3.1.3.5.4.4 Non-lubricated. Gears not operating in a lubrication bath shall be made of corrosive resistant material.

3.3.1.3.5.4.5 Lubricated. Gears operating in a lubricant bath enclosure may be made of noncorrosion resistant materials. The lubricant shall have a corrosion inhibiting additive.

3.3.1.3.5.4.6 Nonmetallic Gears. Nonmetallic gears may be used when they meet load, life, and environmental requirements of the equipment system/subsystem specification. Nonmetallic gears shall be limited to nylon and polytetrafluorethylene.

3.3.1.3.5.5 Special Tools. Special tools are tools designed and developed by the contractor or his vendors to perform a specific operation on special pieces of material and which are necessary to the installation, servicing, testing, adjustment and maintaining of the end article.

3.3.1.3.5.5.1 Use and Authorization. The design of equipment shall be such that the need for special tools for tuning, adjustment, maintenance, replacement, and installation shall be kept to a minimum. Special tools shall be considered only when the required function cannot be provided by an existing standard tool. Necessary tools shall be identified as early as possible. The need for any special tool shall be subject to the approval of FAA.

3.3.1.3.5.5.2 Furnishing and Stowing. Special tools needed for operation and maintenance shall be furnished by the contractor and shall be mounted securely in each equipment in a convenient and accessible place, or in a central accessible location for an equipment array requiring such tools.

3.3.1.3.5.5.3 Tool Life. Special tools shall be capable of performing the required functions throughout the life of the equipment they support.

3.3.1.3.5.6 Springs.

3.3.1.3.5.6.1 Fatigue limits. Electrical conductivity of contact springs shall not be adversely affected by corrosion, operating temperature, and other environmental conditions in service. Fatigue limits shall be consistent with the maximum specified operating cycles for the respective part or equipment or, if such is not specified, with the maximum duty cycle expected during the equipment service life, so as to ensure against premature failure.

3.3.1.3.5.6.2 Design. Springs shall be enclosed or captivated to prevent parts from becoming adrift if broken.

3.3.1.3.5.6.3 Heat Treatment. Springs made of materials that achieved their desired properties by heat treatment (such as copper-beryllium alloys, annealed carbon steels, CRES steels, or heat resisting alloys), shall be heat treated to the specified temper after forming.

3.3.1.3.5.6.4 Grain Orientation. Flexure and forming of spring elements shall be designed to occur perpendicular to the grain of the material. Deviation from the perpendicular shall not exceed 45 degrees. This requirement applies to springs whether heat treated or not.

3.3.1.3.5.6.5 Finishes. Carbon steel springs shall be plated or finished to resist corrosion.

3.3.1.3.5.7 Tuning Dial Mechanisms.

3.3.1.3.5.7.1 Dials. Dial markings shall be legible at a distance of two feet from any point within a solid angle of 60 degrees defined by a surface of revolution about a line throughout the center of the dial and perpendicular to the panel. Minimum space between characters shall be one stroke wide. The width of the lubber line or pointer tip shall not exceed the width of the graduation marks. Except for digital tuning indicators, which only one calibration number will be seen, dials shall be marked so at least two calibration numbers on each band can be seen at any dial setting.

3.3.1.3.5.7.2 Balance and Friction. Weighted tuning knobs shall be counterbalanced. Friction in tuning dial mechanisms shall allow smooth and easy adjustment of the operating knob over the entire operating range of the mechanism, but shall have sufficient resistance or shall incorporate a positive locking device to maintain the setting under all specified service conditions. Friction shall be achieved through dry or elastic resistance rather than by fluid resistance.

3.3.1.3.5.7.3 Flexible Control Shaft. Flexible shaft assemblies conforming to MIL-S-3644 shall be used when a flexible mechanical connection is required between the tuning knob and the tuned device.

3.3.1.3.5.7.4 Tuning Ratio. The tuning ratio used shall be the optimum which will permit both rapid and precise setting.

3.3.1.3.6 Miscellaneous Items.

3.3.1.3.6.1 Gaskets. Gaskets for windows, access doors, and covers if made of synthetic rubber shall conform to MIL-G-1149. Gaskets shall be installed on both sides of windows and shall provide the same degree of enclosure as the housing to which they are secured. The gaskets for access doors and covers shall be cemented or otherwise fixed in place to prevent displacement when such doors or covers are opened or removed.

3.3.1.3.6.2 Glass. All glass used in the equipment, except for cathode ray tubes, shall be of the shatterproof type in accordance with Class 1, Type I, or Class 2 of Specification MIL-G-3787, unless it interferes with equipment operations.

3.3.2 Electromagnetic Compatibility. Electromagnetic compatibility requirements of this specification are applicable to the extent defined in the individual equipment or subsystem specification, contract or purchase order.

3.3.2.1 General. In addition to the requirements specified in Paragraphs 3.3.2.2 through 3.3.2.4, below, all radar and RF transmitting equipment shall meet the applicable technical standards specified in the National Telecommunications and Information Administration (NTIA) Manual of Regulations and Procedures for Radio Frequency Management.

3.3.2.2 Developmental Item. The following requirements shall apply to developmental items.

3.3.2.2.1 Critical Area. Locations containing equipment or subsystems which, if malfunctioning due to uncontrolled electromagnetic energy, either via emissions or susceptibility, could degrade the overall system performance. Devices procured for installation in critical areas shall meet the requirements of MIL-STD-461 for class A1c equipment.

3.3.2.2.2 Non-critical Area. Locations where malfunction will not occur as a result of electromagnetic emissions or susceptibility. Devices procured for installation in non-critical areas shall meet the requirements of MIL-STD-461 for class B equipment.

3.3.2.2.3 Criticality Specified. The procurement specification shall define whether the equipment is intended for critical or non-critical installation.

3.3.2.2.4 Power Equipment. Engine generators and associated components, uninterruptible power sets (UPS), and mobile electrical power (MEP) equipment shall meet the requirements of MIL-STD-461 for Class C2 equipment.

3.3.2.3 Non-Developmental Item (NDI). If the equipment is defined as NDI or COTS in the procurement specification, the contractor shall obtain the appropriate Federal Communications Commission (FCC) authorizations as defined in Title 47, Part 2 and Part 15 of the FCC Rules and Regulations.

3.3.2.4 Telephone Networks. For all equipment designed for interface and connections to public or private switched telephone networks, the contractor shall obtain FCC Registration in accordance with Part 68 of the FCC Rules and Regulations.

3.3.3 Nameplates and Marking. The following paragraphs are not all inclusive since they are marking requirements in other parts of this specification. Marking shall be in accordance with MIL-STD-130 in the event specific markings are not covered in this specification.

3.3.3.1 Nameplates. Each equipment furnished shall have one or more nameplates as determined by the equipment configuration. Each nameplate shall be in accordance with Figure IV. Nameplates shall be attached by removable 4-40 panhead screws.

3.3.3.1.1 Equipment Titles. Unless specifically set forth in the equipment specification, the contractor shall request titles and type designations before preparing and submitting the nameplate drawings to the Contracting Officer. The titles of the equipment specifications shall not be assumed to be the correct equipment titles for use on the nameplates.

3.3.3.1.2 Serial Numbers. Serial numbers shall start with (1) one for each equipment unit having an individual nameplate and continue consecutively up to the total number of such equipment units on the contract. Serial numbers for a given part number shall not be duplicated or reassign by the contract.

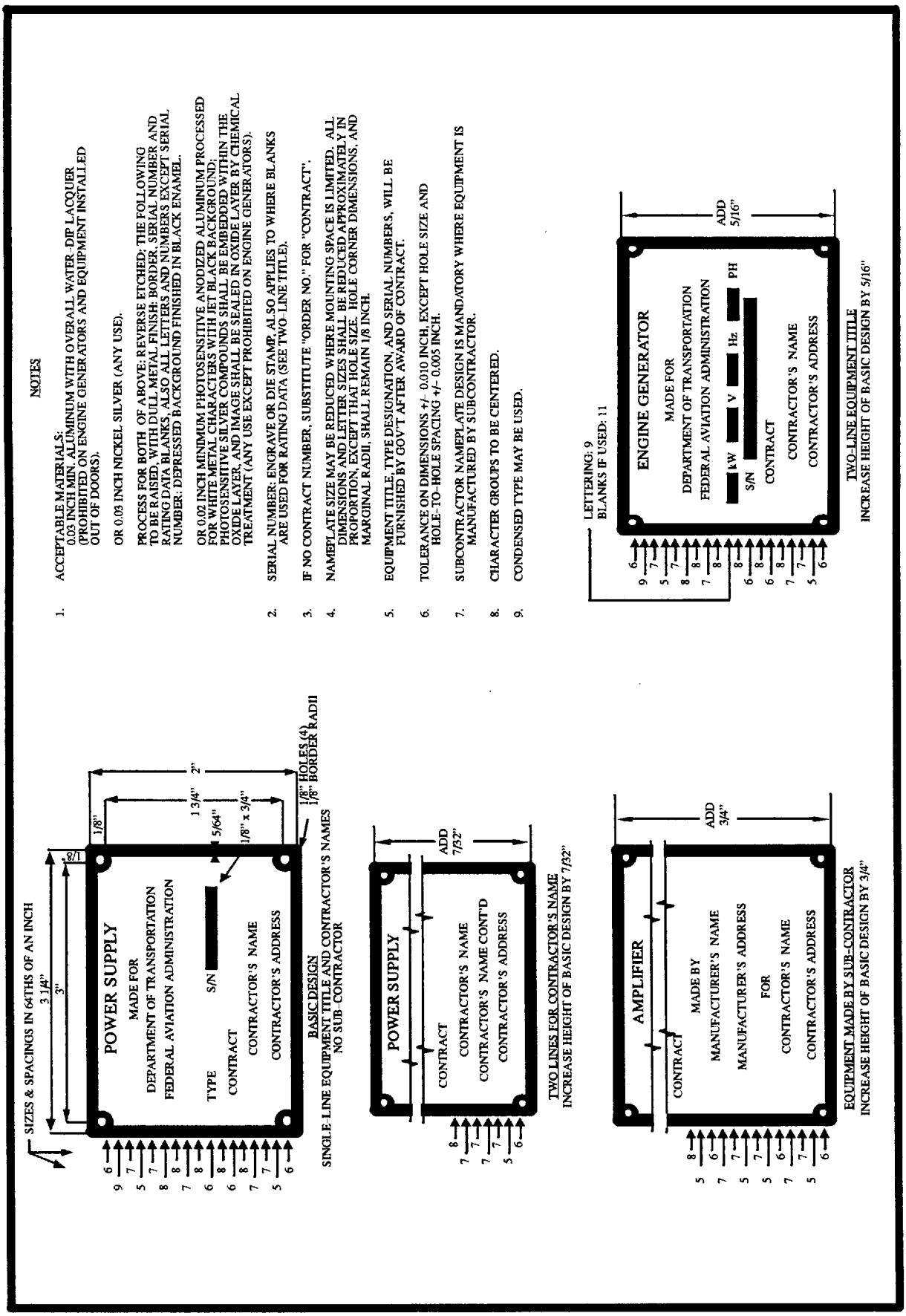


FIGURE IV. STANDARD NAMEPLATE

3.3.3.2 Marking. A marking shall be permanent and legible. A marking shall be as specified in Paragraph 3.2.2.4 and the following paragraphs:

3.3.3.2.1 Visibility of Parts Labels. All parts which have labels or markings identifying data or ratings, should be mounted so that the data are visible to maintenance personnel without the necessity for disassembly of part or of adjacent functional or structural parts. This requirement shall be mandatory whenever it can be applied by the contractor without purchasing made-to-order parts with special markings, and where it can be applied without preventing the use of normally compact assemblies of parts on chassis, such as side-by-side mounting of metal-cased capacitors, or other normal methods of assembly.

3.3.3.2.2 Other Parts Markings. Other parts markings shall be as follows, or per the procurement document and/or MIL-STD-1285.

3.3.3.2.2.1 Radio Frequency (RF) Connectors. All RF connectors furnished on the equipment for the purpose of making external connections shall be clearly identified on the plug-in side by work labels descriptive of their specific functions (e.g., ANT, IF INPUT, RF OUTPUT, etc.).

3.3.3.2.2.2 Ferrule-resistor Positions. All ferrule-resistor positions shall be marked to indicate the ohmic value of the resistor required for the particular position or mounting.

3.3.3.2.2.3 Other Ferrule-mounting Parts. Other parts with ferrule ends, such as, semiconductor rectifiers and vacuum capacitors are mounted in fuse clips, and polarity markings shall be provided where applicable.

3.3.3.2.2.4 Fuse Positions. All fuse positions shall be marked with the rated current capacity of the fuse to be employed therein. Fuse positions for delayed-action fuses shall have the additional designation SLOW. The markings shall be on the insertion side, so as to be visible when replacing fuses. Spare fuse holders shall be marked SPARE.

3.3.3.2.2.5 Terminal Strips and Blocks. The terminals of all terminal strips and blocks, including those which are used for movable links or other adjustable circuit jumpers, shall be identified by numerals or other designations located immediately adjacent to the respective terminals, and marked directly on the terminal strip, block, or immediately adjacent thereto.

3.3.3.2.2.6 Wafer Switches. Markings or other means of identification shall be provided on the equipment to identify the physical locations of wafer switch contacts for circuit tracing purposes.

3.3.3.2.2.7 Controls and Indicating Devices. Markings shall be provided on the front of each exterior and interior panel and panel door, also on control-mounting surfaces of each chassis, sub-panel, etc., to clearly designate the functions and operations of all controls, fuses, and indicating devices mounted thereon, protruding, or available through access holes therein. All markings shall be located on the panel or chassis in correct relationship to the respective designated items.

3.3.3.2.2.8 Polarized Parts. Where mounting arrangements for polarized parts are such that it would be possible for a replacement part to be mounted with terminal positions misplaced or reversed (as in the case of polarized capacitors, diodes or transistors, microelectronics, relays, connectors, transformers) polarity markings shall be provided on the mounting structure of the equipment, located and oriented so that the symbols can be clearly associated with the physical location of the connection points. Devices in the listing below shall have the specific markings indicated:

a. Diodes: The schematic graphical symbol (as used on instruction book diagrams).

b. Transistors and other semiconductor devices having three or more leads: The schematic graphical symbol wherever marking space permits, otherwise identifying letters (such as E, B, C for transistors) or a physical symbol (such as a notch, hole or shape).

c. Polarized capacitors and other devices with plus and minus terminal markings: + −.

3.3.3.2.2.9 Other Electrical Parts. On sub-miniaturized assemblies, transistors, integrated circuits, printed boards or other forms of assembly where space is at a premium, the reference designation need not be marked. In lieu thereof, reference designation marking shall be shown by means of pictorial diagram, line drawings, photographs or other media to provide for circuit identification (by means of reference designations) appropriate for the equipment.

3.3.3.2.2.10 Nonelectrical Parts. Parts such as gears, shafts, hydraulic parts, clutches, covers, and brackets and fastener hardware such as screws and washers are not customarily assigned reference designators unless the items perform electrical functions or removal, replacement and identification of the items by reference designation is essential. If reference designations are required for these items by the equipment specification or statement of work, the designations shall be marked on the chassis, frame, panel, etc., immediately adjacent to the part. If space is not available, the reference designation shall be marked on diagrams provided with the equipment.

3.3.3.2.3 Panel Markings. The visible surface adjacent to panel facilities such as connectors, controls indicators, jacks, keys, switches and fuse holders shall be marked with a suitable word, phrase, or abbreviation, indicating the use or purpose of the part. These markings shall be legible so that the function of the panel facility can be identified by the operator. Continuously variable operating controls shall be provided with markings that permit the operator to set the control to a predetermined point. Markings on the fronts of panels and panel doors (other than equipment nameplates, Paragraph 3.3.3.1) shall be made in accordance with one of the following subparagraphs.

3.3.3.2.3.1 Individual Designation Plates. Designation plates other than nameplates (Paragraph 3.3.3.1), shall be in accordance with MIL-P-15024. Unless otherwise specified in the equipment specification, the contractor shall obtain FAA approval prior to installation.

3.3.3.2.3.2 Markings on the Panel Surface. One of the following processes shall be used:

a. Engraving through the paint and then the engraving filled with contrasting color enamel.

b. Markings by epoxy ink process.

3.3.3.2.4 Interior Marking Methods. Markings on the interiors and rear surfaces of equipment shall be made by one of the following methods, using white markings on dark surfaces and black markings on light surfaces to provide maximum readability:

a. Engraving through paint, or on unpainted surfaces; contrasting color engraving wax or enamel shall be used as a filler except where contrast without filler provides maximum readability.

b. Silk screen process.

c. Stenciling.

d. Individual designation plates in accordance with MIL-P-15024.

e. Hand stamping is allowed for rework or repair only. The hand stamped markings shall not deteriorate due to cleaning the item or exposure to the operating environment. Hand stamped markings shall provide maximum readability.

3.3.3.2.5 Abbreviations. Abbreviations used for front panel markings and other equipment markings shall conform to MIL-STD-12 unless otherwise specified by the equipment specification or statement of work.

3.3.4 Workmanship. Workmanship shall be in accordance with the requirements of MIL-STD-454 Requirement 9.

3.3.5 Interchangeability. Interchangeability shall be as defined in MIL-STD-280 and in accordance with the following:

3.3.5.1 Design Tolerances. Provisions shall be made for design tolerances. Items having the dimensions and characteristics permitted by the item specification may be used as replacements without selection or departure from the specified equipment performance.

3.3.5.2 Use of Standard Items. Standard items shall be used when available. When existing standard items are not available and permission is granted by FAA for use of a nonstandard item, the equipment shall be designed so the nonstandard item can be replaced by the standard item. Appropriate space, mounting holes, and other necessary provisions shall be provided for this purpose unless they conflict with the specified equipment size requirement.

3.3.5.2.1 Use of Non-standard Parts. When a provision is made for substituting or replacing items, the non-standard item being used for replacement shall be identified in the applicable documentation.

3.3.6 Personnel Safety and Health. The design and development of electronic equipment shall provide features for safety of personnel during the installation, operation, maintenance, and repair or interchanging of a complete equipment assembly or component parts thereof. Equipment design for personnel safety shall be equal to or better than the appropriate requirements of the Occupational Safety and Health Act (OSHA) as identified in Title 29, Part 1910, of the Code of Federal Regulations. Human engineering factors affecting safety shall be considered when establishing general or detailed design criteria. The design shall eliminate or mitigate all hazards associated with the following:

a. Hazardous components

b. Safety related interface considerations between the equipment and other portions of the system

c. Environmental constraints including the operating environment

d. Operating, test, maintenance, and emergency procedures

e. Facilities and support equipment

f. Safety related equipment, safeguards, and possible alternate approaches

NDI equipment shall conform to applicable UL or other national standards in effect at time of manufacture. Equipment constructed entirely of NDI shall meet OSHA requirements as described above.

3.3.6.1 Electrical Safety. A means shall be provided to protect personnel from accidental contact with voltages in excess of 30 volts rms or DC during normal operations or maintenance of the equipment. The power input side of the switch and the incoming power line connections shall be given physical protection against accidental contact.

3.3.6.1.1 Ground potential. The design and construction of the equipment shall ensure that all external parts, surfaces, and shields, exclusive of antenna and transmission line terminals, are at ground potential at all times during normal operation. Any external or interconnecting cable, where a ground is part of the circuit, shall carry a ground wire in the cable terminated at both ends in the same manner as the other conductors. In no case, except with coaxial cables, shall the shield be depended upon for a current-carrying ground connection. Antenna and transmission line terminals shall be at ground potential, except for radio frequency (RF) energy on their external surfaces. Plugs and convenience outlets for use with metal cased portable tools and equipment shall have provisions for automatically grounding the metal frame or case of tools and equipment when the plug is mated with receptacle, and the grounding pin shall make first, break last. Except for semiconductor and microelectronic devices, all outer metal cases of parts such as capacitors, transformers, relays, etc., shall be at ground potential or covered by an external casing made of insulating material. The external casing shall enclose the original case on all sides except the terminal sides. A point on the electrically conductive chassis or equipment frame shall serve as the common tie point for the static or power ground.

3.3.6.1.2 Hinged or Slide Mounted Panels and Doors. Hinges or slides are not considered adequate grounding paths, therefore doors and panels with hinges or slides shall be grounded by use of a flexible ground strap. A ground shall be considered satisfactory if the electrical connection between the door or panel and the system tie point exhibits a resistance of 0.1 ohm or less and has sufficient capacity to ensure the reliable and immediate tripping of equipment over-current protection devices.

3.3.6.1.3 Shielding. Except where a conflict with grounding requirements would be created, shielding on wire or cable shall be grounded to the chassis or frame. The shielding shall be at a sufficient distance from exposed conductors to prevent shorting or arcing between the conductor and the shielding.

3.3.6.1.4 Bonding in Hazardous Areas. Electronic equipment that is to be installed in areas where explosive or fire hazards exist, shall be bonded in accordance with NFPA 70.

3.3.6.1.5 Guarding of Radio Frequency (RF) Voltages. Transmitter output terminals, antennas and other devices that carry sufficient RF voltage that may burn or injure personnel shall be protected from accidental contact.

3.3.6.1.6 Interlocks. Various equipment designs require different approaches to the use of interlocks. Interlock use does not modify any other requirements of this standard and shall be consistent with equipment or system specifications. Interlocks shall conform to the following:

a. No interlocks are required when all potentials in excess of 70 volts are completely protected with guards or barriers to prevent accidental contact under all conditions of operation or any level of maintenance.

b. Interlocks are required when voltages between 70 and 500 volts are exposed when the access door, cover or plate is opened. Bypassable interlocks are allowed for these internal voltages that are allowed to be unguarded only if they are not exposed during direct support or operator maintenance.

c. Bypassable interlock switches shall be momentary action (spring-return) switches marked "INTERLOCK BYPASS" and are provided to allow interlocked access doors and covers to be opened with a manual latch for "on" position to be operated in the exposed interlock switch, without removing power from the equipment. The bypass switches shall be located so that one person can operate the switch, open the door or cover, and set the manual latch.

d. Non-bypassable interlocks are required for voltage in excess of 500 volts, when the access door, cover, or plate is opened.

3.3.6.1.7 Shorting Rods. Shorting rods shall be provided with all transmitting equipment where voltages are in excess of 70 volts rms or Direct Current (DC). Wherever size permits, shorting rods shall be stored within the transmitting equipment and be permanently attached and readily accessible to maintenance personnel.

3.3.6.1.8 Meter Safety. Meters shall have provisions for overload bypass, or alternate protection to eliminate high voltage potential or current at the terminals in the event of meter failure. In addition, meters shall be provided with protection so that not over 1500V, maximum peak value, shall exist between any terminal of each meter and the metal panel on which it is mounted in the equipment.

3.3.6.1.9 High Voltage Protection. Assemblies operating at potentials in excess of 500 volts shall be completely enclosed from the remainder of the assembly and interlocked in accordance with the requirements herein. Test probe holes may be provided in the barriers or guards where maintenance testing is required. When the operation or maintenance of equipment is employing potentials in the excess of 300 volts peak, the equipment shall be provided with test points so these voltages can be measured at a relatively low potential level, but in no case shall the potential exceed 300 volts peak relative to ground. Test points with voltages above 30 volts shall have the conducting material recessed at a distance no less than the diameter of the probe hole and a minimum of 0.06 inch. If a voltage divider is used, the voltage divider resistance between the test point and ground must consist of at least two equally valued resistors in parallel. Full details shall be given in the instruction book or maintenance manual as to the method used in the equipment to obtain the voltage at the test points.

3.3.6.1.10 High Current Protection. All power buses supplying 25 amperes or over shall be protected against accidental short circuiting by tools, jewelry or removable conductive assemblies.

3.3.6.1.11 Discharging Devices. Discharging devices shall be provided to discharge high voltage circuits and capacitors unless they discharge to 30 volts within two seconds or less after power removal. These protective devices shall be positive acting, highly reliable, and shall actuate automatically when the case or rack is opened. Shorting bars shall be actuated either by mechanical release or by an electrical solenoid when the door or cover is open. When resistive bleeder networks are used to discharge capacitors, the bleeder network shall consist of at least two equal valued resistors in parallel. The particular discharging device that is chosen must ensure that the capacitor is discharged to 30 volts or less within two seconds.

3.3.6.1.12 Connectors, Electrical. The design of the connector shall be such that the operator is not exposed to electrical shock or burns when normal disconnection methods are used. Exposed pin contacts shall not be energized (hot) after being disconnected from the socket contacts.

3.3.6.2 Radio Frequency (RF)/Microwave, X, and Laser Radiation Limits.

3.3.6.2.1 Applicability of Federal Standards. The design of all equipment for which a federal standard exists under the Code of Federal Regulations (CFR), Title 21, Chapter I, Subchapter J shall conform to the appropriate federal standard.

3.3.6.2.2 Radiation Hazards and Protection. All electronic equipment or electrical devices capable of emitting x-radiation or RF/microwave radiation between 300 Khz and 100 GHz shall be designed, fabricated, shielded, and operated to the requirements of FAA Order 3910.3A.

3.3.6.2.3 Laser Radiation. Laser equipment and system design, installation, and written operational and maintenance procedures shall conform to CFR, Title 21, Chapter I, Subchapter J, Part 1040.

3.3.6.3 Switches.

3.3.6.3.1 Safety Switches. Safety switches which deactivate associated mechanical drive units shall be provided for the purpose of disconnecting these units without disconnecting other parts of the equipment. All remotely located units and assemblies shall have provisions to prevent overriding safety switches to allow independent disconnecting in the associated equipment.

3.3.6.3.2 Momentary Override. Momentary contact switches may be used to override interlocks and permit access to the manual override for efficient servicing.

3.3.6.4 Mechanical Hazards. The design of the equipment shall provide safety to personnel while installing, operating, and maintaining the equipment. The design of rack mounted equipment shall locate the center of gravity as low as practical to minimize tipping over. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears, fans, and belts when the equipment is complete and operating. Sharp projections on cabinets, doors, and similar parts shall be avoided. Doors or hinged covers shall be rounded at the corners and provided with stops to hold them open. Provisions shall be enhanced to prevent accidental pulling out of drawers or rack mounted equipment components which could cause equipment damage and injury to personnel. Equipment power switches shall be so designed and located that accidental contact by personnel will not change the equipment state.

3.3.6.4.1 Mechanical Interconnection. The design shall provide positive means to prevent the inadvertent reversing or mismatching of fittings, couplings, fuel, oil, hydraulic, pneumatic lines, mechanical linkage, and instrument leads and electrical connections. When prevention of mismatching by design considerations is not feasible, coding or marking shall be employed when approved by FAA. Coding and marking will not be approved as a substitute for proper design of items involving explosives, emergency, or safety critical systems.

3.3.6.4.2 Cathode Ray Tubes (CRTs). Cathode ray tubes shall conform to the requirements of UL 1418.

3.3.6.4.3 Glass Fibers. Glass fibrous materials shall not be used as the outer covering on cables, wire or other items where they may cause skin irritation to operating or maintenance personnel unless specified in the equipment specification.

3.3.6.5 Markings, Signs, Tags, and Symbols.

3.3.6.5.1 Markings.

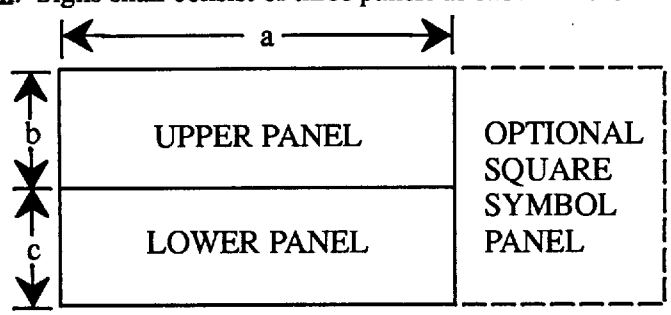
a. Guards, barriers, and access doors, covers or plates shall be marked to indicate the hazard which may be reached upon removal of such devices. When possible, marking shall be located such that it is not removed when the barrier or access door is removed. Additionally, warnings of hazards internal to a unit shall be marked adjacent to hazards if they are significantly different from those of surrounding items. Such a case would be a high voltage terminal in a group of low voltage devices.

b. Physical hazards shall be marked with color codes in accordance with ANSI Z535.1 where applicable to electronic equipment.

c. Center-of-Gravity shall be marked on equipment which has a center-of-gravity 50 percent different from the center-of-volume of the chassis.

3.3.6.5.2 Accident Prevention Signs and Labels. Accident prevention signs and labels should be used whenever equipment has characteristics or operating conditions which present a hazard to operators, maintainers, or other personnel. The purpose of such signs and labels is to indicate the nature of the hazard and to provide information so that injury and property damage may be avoided. Equipment which has such hazards as voltage, current, thermal, physical, laser radiation, RF radiation, etc. associated with operations or maintenance shall be properly labeled. Signs and labels shall be as permanent as the normal life expectancy of the equipment on which they are affixed.

3.3.6.5.2.1 Sign Design. Signs shall consist of three panels as shown in the following diagram.



General Layout - Two Panel Sign With Optional Symbol Panel

The ratio of width to height of the upper panel (a:b) shall fall within the range of 2:1 to 5:1 inclusive. The lower panel shall be equal to the upper panel width (both equal to a). The lower panel height shall be equal to or greater than the upper panel height, but less than twice the width of the sign (b<=c<2a). The optional symbol panel shall be square with its edge equal to the sum of the upper and lower panel (b+c) and placed to the right. The upper panel shall contain the signal or key word. The lower panel shall contain additional direction or explanation. Wording of this panel should be brief, provide positive direction if possible, and be limited to a single hazard.

3.3.6.5.2.2 Sign Classifications and Detailed Design.

3.3.6.5.2.2.1 Class I (Danger). These signs indicate immediate and grave danger or peril, a hazard capable of producing irreversible damage or injury, and prohibitions against harmful activities. These signs shall have the word 'DANGER' in white within a red oval outline with a white on black rectangle in the upper panel. The lower panel, for additional wording, shall be in black or red on a white background.

3.3.6.5.2.2.2 Class II (Caution). These signs are used to call attention to potential danger or hazard, or a hazard capable of or resulting in severe but not irreversible injury or damage. These signs shall have the signal word 'CAUTION' in yellow on a black rectangle in the upper panel. the lower panel, for additional wording, shall be in black on a yellow background.

3.3.6.5.2.2.3 Class III (General Safety). These signs include notice of general practice and rules relating to health, first aid, housekeeping, and general safety other than the two cases above. These signs shall have the appropriate keyword in white on a green rectangle in the upper panel. The lower panel, for additional wording, shall be in black or green on a white background.

3.3.6.5.2.2.4 Class IV (Fire and Emergency). These signs shall be used only to label or point the way to fire extinguishing equipment, shutoffs, emergency switches, and emergency procedures. These signs shall have the keyword in white on a red rectangle in the upper panel. The lower panel, for additional wording, shall be in red on a white background.

3.3.6.5.2.3 Sign placement.

a. Signs shall be placed so as to alert and inform in sufficient time to avoid the hazard or to take appropriate action.

b. Signs shall be placed so as to be readable from a distance commensurate with a. above, create no additional distractions, or be hazards themselves. Care should be taken to avoid grouping too many signs or labels together in one location.

c. MIL-STD-1472 shall be used for additional guidance for general label placement. However, signs and labels shall be placed as near as possible, commensurate with a. through b. above, to the hazard or its control.

3.3.6.5.3 Marking of Radioactive Materials. The marking or labeling of commodities containing radioactive materials shall be in accordance with Nuclear Regulatory Commission Rules and Regulations CFR, Title 10, Chapter I, Part 20 and OSHA Regulation CFR, Title 29, Part 1910.96.

3.3.6.5.4 Symbols. The following symbols shall be used as applicable:

a. Ionizing radiation hazard - ANSI N2.1.

b. Microwave and radio frequency radiation - FAA order 3910.3A.

c. Laser symbol - CFR, Title 21, Chapter I, Subchapter J, Part 1040.

3.3.6.5.5 Alerts/Warnings. All warning displays shall provide the operator with a greater probability of detecting the alerts/warnings than normal observation of the equipment would, in the absence of the display.

3.3.6.5.5.1 Audio Warning Signals. Audio signals shall be provided as necessary to warn personnel of impending danger, to alert operators to critical system changes or equipment status, or to remind operators of a critical action which must be taken. An alert/warning signal shall provide an audio intensity such that a signal-to-noise ratio of 20 decibel (dB) is achieved in at least one octave band between 200 and 5,000 Hertz. The resulting intensity shall not exceed the safety levels of Paragraph 3.3.7.1.5.

3.3.6.5.5.2 Display Warnings. Video display warnings shall be provided on equipment with associated video displays to warn operators of impending danger, to alert operators to critical system changes or equipment status, or to remind operators of a critical action which must be taken. Display alert/warnings shall be designed to incorporate clearly discriminative features which distinguish the warning (Color, blink, size, etc.) from other display information.

3.3.6.6 Hazardous and Restrictive Materials. Assessment of the hazard potential of a substance and its decomposition products shall be performed prior to material selection. The assessment shall include the relative toxicity of the substance (and decomposition products) as well as the nature of the potential exposure to personnel and equipment.

3.3.6.6.1 Carcinogens. Certain chemicals have been identified by the Occupational Safety and Health Administration (OSHA) as cancer-producing substances (carcinogens). Before using any materials which might contain these chemicals, they should be evaluated in accordance with the CFR, Title 29, Chapter XVII, Part 1910.

3.3.6.6.2 Dusts, Mists, Fumes, and Gases. The materials installed in the equipment and under service conditions specified in the specific equipment specification, shall not liberate gases which when combined with the atmosphere form an acid or corrosive alkali, nor shall they generate toxic or corrosive dusts, mists, or fumes which would be detrimental to the performance of the equipment or health of the equipment operators. In addition to equipment operators, gases or fumes shall not be detrimental to plants, fish or wildlife if vented to the outside. The materials also shall not liberate gases which will produce a flammable or explosive atmosphere.

3.3.6.6.3 Restricted Materials. Mercury and asbestos shall not be used.

3.3.6.6.4 Radioactive Materials. Use of radioactive materials shall conform to Nuclear Regulatory Commission Regulations and shall require approval of FAA. Radium shall not be used to achieve self-luminosity.

3.3.7 Human Engineering. General human engineering for design and development of electronics equipment shall be in accordance with this section and MIL-STD-1472 as tailored per Appendix V. NDI shall use MIL-STD-1472 as tailored per Appendix V. NDI shall meet the noise requirements of Paragraphs 3.3.7.1 through 3.3.7.2.

3.3.7.1 Noise Criteria Requirement. These noise requirements shall apply to all equipment. Equipment located in areas normally requiring verbal communications shall meet the requirements based upon area use as described below. Equipment located in areas not requiring verbal communications shall not exceed hazardous levels as described in Paragraph 3.3.7.1.4. Sound pressure levels generated by the equipment, with motors, blowers and all other sources of acoustic noise in normal operation shall not exceed the levels described below. Only the equipment under test shall be in operation for noise measurement purposes. Noise generated, if not contained indoors, shall conform to local ordinances in accordance with the Noise Control Act of 1972.

3.3.7.1.1 Equipment for Operational Areas. Operational areas are those areas requiring frequent telephone or radio use or occasional direct verbal communication at distances up to 1.5 M (5 feet). Operations areas have considerable critical telephone and radio communication. Equipment located in operational areas shall not exceed 55 dB(A). (Operations centers, Control Rooms, Tower Cabs, Dynamic Simulation Rooms.)

3.3.7.1.2 Equipment for Equipment Areas. Equipment areas are those areas requiring occasional telephone use or occasional direct verbal communications at distances up to 1.5 M (5 feet). Such areas may be either manned or unmanned. Equipment located in general work areas shall not exceed 65 dB(A). (Computer rooms, engineering areas, equipment rooms, telephone switching center.)

3.3.7.1.3 Equipment for Special Areas/Offices. Special areas or offices are those areas requiring no difficulty with direct verbal communications. Operations areas have considerable direct verbal communication. Equipment located in special areas shall not exceed 45 dB(A). (Conference rooms, Operations areas, Libraries, Administrative Offices, Training Classrooms.)

3.3.7.1.4 Equipment for High Noise/Remote Areas. Remote areas are those areas located away from operations. These areas are normally unmanned. High noise areas are those areas which exceed 65 dB(A). Equipment located in high noise/remote areas shall not exceed 85 dB(A), unless approved by the FAA.

3.3.7.1.5 Identification of Noise Hazard Areas and Equipment. Persistent noise levels of greater than 85 dB(A) or impulse noise above 140 dB peak pressure level, regardless of exposure time, at operator or crew positions where one or more individuals will be located, including occasionally occupied positions, require that noise caution signs shall be permanently posted on the equipment. They shall be clearly visible and legible to all personnel exposed to the hazard. In addition, operations and maintenance manuals shall contain appropriate discussion of noise hazards. Discussion shall include the requirements for hearing protection, type of hearing protection recommended, the noise level of the equipment and the distance at which the 85 dB(A) or 140 dB peak pressure level will be met.

3.3.7.2 Ergonomic Considerations. Design of equipment shall accommodate the fifth through the ninety fifth percentile male and female user population. Where the user population characteristics are not known, MIL-STD-1472 "Ground Troops" data may be used for males and the female data used for females. MIL-STD-1472, Paragraph 5.6 presents this data.

3.3.7.3 Weight Lifting Limits. The weight lifting limits of Table XI conditions A and B shall be used as maximum values in determining the design weight of items requiring one person lift with two hands. Double the weight limits shown shall be used as the maximum values in determining the design weight of items requiring two person lifting, provided the load is uniformly distributed between the two lifters. If the weight load is not uniformly distributed, the weight limit applies to the heavier lift point. Where three or more persons are lifting simultaneously, not more than 75 percent of the one person value may be added for each additional lifter provided that the object lifted is sufficiently large that the lifters do not interfere with one another while lifting.

Other considerations including the following factors shall be considered with respect to weight limits: carrying limits, carrying frequency, carrying distance or time, object carry size, user population, and push and pull forces. Refer to MIL-STD-1472 for further details.

TABLE XI. DESIGN WEIGHT LIMITS

	HANDLING FUNCTION	MALE & FEMALE		MALE ONLY	
		kgs	Lbs	kgs	Lbs
A	Lift an object from the floor and place it on a surface not greater than 1.525 m (5 ft) above the floor.	16.8	37	25.4	56
B	Lift an object from the floor and place it on a surface not greater than 915 mm (36 in) above the floor.	20	44	39.5	87
C	Carry an object 10 m (33 ft) or less.	19	42	37.2	82

3.3.7.4 Visual Displays. Visual displays should be used to provide operators and maintainers with clear indication of equipment condition for operation under any eventuality commensurate with the operational and maintenance philosophy.

3.3.7.4.1 Display Illumination and Light Distribution. Display illumination shall be commensurate with all operational uses of the equipment. Such factors as dark adaptation, interior vs. exterior use, and use under all anticipated illumination types (e.g., fluorescent, incandescent, direct sun) shall be considered. Display illumination shall be consistent across groups of displays.

3.3.7.4.2 Display Information. All information generated by the equipment shall be capable of display to an operator and shall be sufficient to allow the operator to correctly operate the equipment. Such information shall be limited to that which is necessary to perform specific actions or to make decisions and shall be selectable by the operator. Information display shall consider such factors as location, consistency, content, precision, format, redundancy, effects of display partial failure, duration, timeliness, and amount.

Numeric digital displays shall not be used as the only display of information when perception of pattern or variation is important to correct comprehension of the information. Numeric digital displays shall not be used when rapid or slow digital display rates inhibit proper understanding.

3.3.7.4.3 Display Positive Feedback. Changes in displays status shall signify changes in functional status rather than changes in control input. The absence of an indication shall not be used to indicate critical occurrences (i.e., indicates that the valve has actually closed and not that the button has been pushed or voltage applied).

3.3.7.4.4 Light-emitting Diodes (LED) Displays. LEDs may be used for transilluminated displays, including legend and simple indicator lights, and for matrix (alphanumeric) displays. LED colors shall be chosen to conform with the following; i.e. green good, ok, on; yellow/amber warning, in use; red danger, error, off nominal. NDI shall conform to these color preferences except that red may be used as a power on indicator.

3.3.7.4.5 Flash. The use of flashing indicators or CRT areas shall be minimized. Flash shall be used only when it is necessary to call attention to some condition requiring immediate attention. The flash rate shall be between 3 and 5 flashes per second with approximately equal on and off times. Flashing lights or CRT areas which could flash at the same time shall be synchronized so that they flash on together.

3.3.7.4.6 Display Type Consideration.

3.3.7.4.6.1 CRT Displays. Equipment which incorporates a CRT shall be designed such that the display has a viewing distance of 400 mm (16 inches) for monochrome displays and 600 mm (24 inches) for color displays wherever practical. Ambient illumination (nominally 50 foot-candles or as stated in the equipment specification) shall not contribute more than 25% of the screen area brightness through diffuse reflection or phosphor excitation. Surfaces adjacent to CRT displays shall be between 10% and 100% of screen background luminance. With the exception of emergency indicators, no light source in the immediate surrounding area shall be of greater luminance than the CRT signal. Reflected glare shall be minimized by selection of appropriate display technology or the use of a hood or shield. The font style selected shall allow discrimination of similar characters such as the letter l and the numeral 1.

3.3.7.4.6.2 Electroluminescent Displays. Electroluminescent (EL) displays may be used where ever equipment requirements dictate the use of transilluminated displays. In addition, they may replace existing mechanical instrumentation while offering advantages of lighter weight, conservation of panel space, lower power requirements, less heat production, uniform distribution of illumination, longer operational life, elimination of parallax, and flexibility of information presentation. EL displays may also be used where sudden lamp failure could result in catastrophic consequences. EL displays shall be protected against impact where extreme handling environments exist.

3.3.7.4.6.3 Liquid Crystal Displays. Liquid Crystal Displays (LCD) consist of reflective and backlit types. Backlit types may be used under similar conditions as EL displays except that they must be protected from temperatures below zero degrees Centigrade. Reflective displays may be used only where adequate ambient illumination is assured or where the display is externally illuminated. Viewing angle shall be compatible with the display technology selected because some LCDs are incompatible with off normal view angles. Where equipment will be exposed to extreme temperature conditions LCDs shall be used only with the explicit permission of the FAA. NDI equipment with manufacturer's specifications that meet or exceeds required temperature extremes may be used without permission. LCDs may also be used where sudden lamp failure could result in catastrophic consequences. LCDs shall be protected against impact. LCDs shall be protected from direct sunlight.

3.3.7.4.6.4 Plasma Displays. Plasma Displays may be used under similar conditions as EL displays except that users and maintainers shall be protected from their associated high voltage.

3.3.7.4.6.5 Display Characteristics. EL, LCD, Plasma and other displays shall be such that the displayed characters and graphic symbols height exceeds 4.5 mrad (15 minutes) of visual angle. View angle shall be considered to ensure legibility with all operational uses of the display.

3.3.7.5 Labeling. Labels, legends, placards, signs, tags, markings or a combination of these shall be provided to identify, interpret, follow procedures, or avoid hazards. Labels and information shall be oriented horizontally, placed near the items they identify, placed and grouped to avoid confusion, and placed in a consistent fashion. Labels shall be brief, use words familiar to operators, be easily readable from distances expected with the equipment's use, not covered with tags or obscured by components, and have contrasting background color from the equipment. Label characters shall conform with MIL-STD-1472 Paragraph 5.5.5.

3.4 Documentation. Documentation shall be in accordance with the contract requirements. FAA-D-2494 provides detailed guidance regarding general requirements for technical instruction book manuscript. MIL-STD-1388 provides detailed guidance regarding general requirements for logistics documentation.

3.5 Logistics. Logistics shall be accomplished by utilizing the MIL-STD-1388 process and applying other documentation as identified in the statement of work (SOW).

3.5.1 Facilities and Facility Equipment. Facilities and facility equipment shall be in accordance with the contract requirements.

3.6 Personnel and Training. Personnel and training shall be in accordance with the contract requirements. FAA-STD-028 provides detailed guidance regarding training.

3.7 Major component characteristics. Major component characteristics shall be in accordance with the contract requirements.3.8 Precedence. Precedence shall be in accordance with the contract requirements.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Quality System Requirements. Quality Assurance concepts shall be considered in all aspects of the acquisition process. The following sections define the minimum requirements for NDI, COTS and developmental products.

4.1.1 NDI and COTS Items. A documented and verifiable quality system shall be implemented and maintained by the contractor. This system is subject to evaluation by the FAA and shall include the following.

a. Material Evaluation

b. Qualification Evaluation

c. Quality Conformance Evaluation

d. Process Control Evaluation

In addition, all tests and inspections of COTS or NDI made by the contractor shall be subject to Government evaluation and/or verification as defined in Paragraph 3.1.1 and specified in Paragraph 4.4.

4.1.1.1 Material Evaluation. Material evaluations normally consist of certification by the manufacturer and are supported by verifying data that all materials which become part of the finished product are in accordance with the specified requirements.

4.1.1.2 Qualification Evaluation. Qualification evaluations establish the contractor's capability for designing, developing or manufacturing the product/equipment within the equipment system/subsystem specification. Qualification evaluation may include, but not be limited to, qualification; i.e. shock, vibration, EMI, handling, etc.

4.1.1.3 Quality Conformance Evaluation. Quality conformance evaluations verify that the product/equipment is in accordance with the specified requirements. Quality conformance evaluations may include, but not be limited to, visual inspections and functional testing.

4.1.1.4 Process Control Evaluation. Process control evaluations verify each process used to produce a product/equipment identify, and properly define the specified requirements. Process control must be a documented system, available for review and the means to improve the process of products and services. Process control evaluations may rely upon the use of measurement techniques such as Statistical Process Control (SPC) and Computer Aided Software Engineering (CASE) tools.

4.1.2 Developmental Items. A quality system shall be defined, implemented and maintained by the contractor in accordance with the contract schedule and the requirements of FAA-STD-013 or FAA-STD-016 as specified in the contract.

4.2 Verification/Compliance to Requirements. This section specifically applies to developmental items. For NDI or COTS requirements, see Paragraph 4.4.

4.2.1 Availability of Applicable Documents. A complete set of the applicable documents, specifications, publications, and drawings, except those issued by FAA for the equipment being furnished on the contract, shall be made available by the contractor for use by the FAA QRO.

4.2.2 Inspection of Design and Production Status. Upon request from the Government, the contractor shall make available for review at his plant, at any stage of the contract, all information regarding the design and production status of the equipment under contract.

4.2.3 Subcontract, Purchase Order and Invoice Submission. The FAA QRO, upon request, shall be provided a copy of applicable purchase orders for Government verification purposes. The FAA QRO, upon request, shall be provided copies of invoices covering shipments of items from the supplier's facilities to that of the prime contractor.

4.2.4 Certification Documentation. The FAA QRO, upon request, shall be provided certification documentation. Such documentation shall verify that the supplier's certification furnished meets the requirements of Paragraph 3.3.1.3.1.1. This certification must be traceable to the part or material manufacturer's quantitative test data pertaining to the specific part or material. After receipt of the parts and materials at the contractor's plant, the FAA QRO may carry out visual and other inspection, and in cases of doubt, request certified test data.

4.3 Testing Requirements. The following Paragraphs include general and specific information pertaining to all aspects of the product/equipment testing requirements of developmental items. For COTS/NDI requirements see Paragraph 4.4.

4.3.1 Contractor's Detailed List of Tests. A list of proposed tests shall be prepared as a means of proving compliance with the performance requirements of the equipment specification. This list shall identify all detailed tests, by title, to be performed and shall be available to the Government for review and acceptance. All test procedures shall reference the specification paragraph number being demonstrated. In addition to the proposed tests, the list shall include the tests of Paragraph 4.3.2 unless they are specifically excluded in the equipment specification or contract schedule.

4.3.2 Classification of Tests. Five classes of tests are required, as follows, unless otherwise specified by the contract:

a. Contractor's Preliminary Tests (Paragraph 4.3.2.1)

b. Design Qualification Tests (Paragraph 4.3.2.2)

c. Type Tests (Paragraph 4.3.2.3)

d. Production Tests (Paragraph 4.3.2.4)

e. FCC Type Acceptance and Registration Procedures (Paragraph 4.3.2.5)

When specified by the contract, reliability and/or maintainability demonstration tests (Paragraph 4.3.2.8) shall be conducted in accordance with the approved Reliability/Maintainability Program Plan.

4.3.2.1 Contractor's Preliminary Tests. Prior to notification to the Government that the initial production equipment is ready for inspection, one complete set of all tests required by the equipment specification and this general specification shall be made available to the Government. These preliminary tests shall be made on one production equipment or on one prototype (preproduction) model. Preliminary tests do not constitute any of the regular design qualification tests, type tests, reliability-maintainability tests, or production tests (nor FCC Type Acceptance and Registration Procedures tests where applicable under Paragraph 3.3.2.4) required by the equipment specification or by this general specification.

4.3.2.1.1 Preliminary Test Data.. A certified copy of the test data covering all preliminary tests shall be submitted to the Government Contracting Officer. This test data may be submitted along with the proposed test procedures and forms under FAA-STD-013, FAA-STD-016, or the contract schedule, but in any case, the test data shall be submitted not less than 15 work days in advance of the date set for inspection pursuant to Paragraph 4.3.3.

4.3.2.1.2 Submission of Test Documentation. Submission for approval of test data shall be as specified in FAA-STD-013, FAA-STD-016, or the contract schedule, as applicable.

4.3.2.2 Design Qualification Tests. The following tests shall be performed once, prior to, or concurrent with the first type test, on regular production equipment selected by the Government Representative.

a. Rating verification, parts and materials (Paragraph 4.3.2.2.1)

b. Other general specification tests (Paragraph 4.3.2.2.2)

c. Design qualification tests as required by the equipment specification

4.3.2.2.1 Rating Verification of Parts and Materials. Measurements and/or calculations shall be made in order to establish that the parts (see Paragraph 3.3.1.3) and insulating materials (see Paragraphs 3.3.1.1.1 through 3.3.1.1.7; 3.3.1.3.4.26.3/4/7/9/10/18/19) used in the equipment will not be subjected to voltages, currents, power dissipation, and temperature, in excess of the derated values permitted by applicable specification requirements and this specification. All power supplies over 600 volts which are potted or encapsulated shall be subjected to a 48 hour heat run with all critical internal components instrumented to insure that proper temperature derating has been incorporated in the design. The instrumented heat run shall be performed with the power supply operating in the equipment in its final configuration location. At the inspection location specified in the contract, any rating verification, parts and material data requested by the FAA, shall be made available in order to review the adequacy of measurements and/or calculations.

4.3.2.2.2 Other General Specification Tests. Tests shall be performed once, prior to, or concurrent with the first type test on regular production equipment to establish that the applicable requirements of Table XII are being met.

4.3.2.3 Type Tests. Type tests are performed to verify that the equipment or system operates over the range of specified service conditions. These tests shall be performed on regular production equipment or systems in accordance with the requirements herein.

TABLE XII. GENERAL SPECIFICATION TESTS

SPECIFICATION REQUIREMENT	PARAGRAPH NO.
Transient Protection	3.1.2.7
Noise levels	3.3.7
Interlock bypass switch voltage limitations (at maximum line voltage in service conditions range)	3.3.6.1.6
X-radiation	3.3.6.2
Ground potentials	3.3.6.1.1
Exhaust air temperature	3.1.3.5.2
AC line controls	3.1.2.2.1/3.1.2.2.5
AC line inputs resistance to ground (service conditions of temperature and humidity)	3.1.2.2.3
Transformer isolation, DC power supplies	3.1.2.2.6
Electrical load balance (when applicable)	3.1.2.4.1
Power factor	3.1.2.4.2
Equipment effect on power source (when applicable)	3.1.2.4.3
Equipment response versus condition of primary input power	3.2.1.5
Electromagnetic compatibility	3.3.2
Meter switching:	
Peak voltage	3.3.1.3.4.12.1
Accuracy	3.3.1.3.4.12.2
Motor protection, locked rotor	3.3.1.3.4.15

4.3.2.3.1 Type Test Equipment Selection. The equipment selection for type testing shall be in accordance with the contract schedule and/or the equipment specification. In the absence of specific requirements in the contract schedule or the equipment specification, the following subparagraphs apply:

4.3.2.3.1.1 Identification. The equipment on the contract shall be assigned sequential numbers in order as they reach the stage of completion and readiness for testing. Using these sequential numbers, the equipment shall be divided into groups for type testing as shown in Table XIII. One type test shall be performed for each type test group. (The essential characteristic of any type test group must be homogeneity.) With the exception of Type Test No. 1, selection of an equipment for type test within the group shall be made by the FAA Quality representative.

4.3.2.3.1.2 Release to Final Inspection. Unless otherwise specified in the equipment specification, when the type test is successfully completed, the equipment in the group from which the type test equipment was taken is released for final inspection and subsequent shipment. The equipment in the next succeeding type test group are released for inspection and production testing only. If it is the last type test group, successful completion of type test releases all remaining equipment for final inspection and subsequent shipment.

TABLE XIII. TYPE TEST EQUIPMENT SELECTION

Contract Qnty	TYPE-TEST GROUPS							
	I	II	III	IV	V	VI	VII	VIII
1-10	1							
11-25	1	2-10						
26-50	1	2-10	11-35					
51-75	1	2-10	11-35	36-60				
76-100	1	2-10	11-35	36-75				
101-150	1	2-10	11-50	51-100				
151-200	1	2-10	11-50	51-100	101-150			
201-300	1	2-10	11-50	51-100	101-150	151-200		
301-500	1	2-10	11-50	51-100	101-200	201-300	301-400	
501-700	1	2-10	11-50	51-100	101-200	201-300	301-400	401-600
701 & up	As specified in the procurement document.							

4.3.2.3.1.3 Anomalies. If a type test is not successfully completed and requires parts and/or design changes in order to meet the specified type test requirements:

a. These parts and/or design changes, shall be incorporated in the group from which the type test equipment was taken, and all equipments retested to the extent determined necessary by FAA, prior to final inspection, acceptance or delivery.

b. A plan should be submitted for approval to the Government for the correction/ modification of previously accepted and delivered equipments in accordance with applicable contract warranty provisions and the requirements herein shall be proposed. For field modifications, the necessary parts, instructions and instruction manual revisions in accordance with FAA Order 1320.33 "Equipment Modification and Facility Instruction Directives" shall be provided.

4.3.2.4 Production Tests. Production tests shall be performed in accordance with the Government approved test procedures on each production equipment.

4.3.2.5 FCC Type Acceptance and Registration Procedures. Where applicable under Paragraph 3.3.2.4, the first production equipment delivered to the government shall be subjected to the FCC type acceptance and registration procedures in accordance with FCC Rules and Regulations: Title 47, Part 2, and Part 68. The environmental temperature range specified by the FCC shall supersede, for the purposes of the FCC Type Acceptance Procedures, the service conditions temperature range which is applicable under the equipment specification and this specification. In addition, during the life of the contract, compliance shall be maintained with FCC Regulations in connection with any approved changes made to the production equipments which are relevant to the FCC Type Acceptance or Registration.

4.3.2.5.1 FAA Acceptance Contingent on FCC Type Acceptance. The Government Contracting Officer shall be furnished a copy of the FCC Notice to applicant of type acceptance letter or postcard, or, if type acceptance is granted by FCC without such written notice, the certification to that effect, dated and signed by a responsible official as a condition for acceptance of the equipment by the Government under the contract.

4.3.2.5.2 FAA Acceptance Contingent on FCC Type Registration. The Government Contracting Officer shall be furnished a copy of the FCC Form 484, entitled "Registration under Part 68", or if registration is granted by FCC without such documentation, the certification to that effect, dated and signed by a responsible official as a condition for acceptance of the equipment by the Government under the contract.

4.3.2.6 Fail-safe Demonstration Test. Where required by the contract, a fail-safe demonstration test shall be performed on a production article.

4.3.2.7 RMS Fail-soft Demonstration Test. Where required by the contract an RMS fail-soft demonstration test shall be performed on a production article.

4.3.2.8 Reliability and/or Maintainability Demonstration Tests. Where required by the contract, life tests and formal reliability and/or maintainability demonstration tests shall be conducted as required in the contract. Reliability and/or maintainability demonstration tests shall be performed on regular production equipment. Preventive maintenance shall be allowed only to the extent as specified in the equipment specification.

4.3.3 Notification of Readiness for Inspection. After submission of the preliminary test data, and one or more production equipments are completed (i.e., equipments produced to meet all specification requirements), the Government Contracting Officer shall be notified in writing of the readiness for Government Inspection. Such notification shall be given in time to reach the Contracting Officer not less than seven work days before inspection is to start. Notification for production acceptance testing shall be provided per the following criteria:

a. Requests shall not require more than 2 workdays of advance notification if the QRO is on site at the contractor's facility, or

b. Requests in writing to the Government Contracting Officer shall be provided in time to provide not less than seven work days before inspection is to start.

4.3.4 Testing Considerations/Conditions.

4.3.4.1 AC Line Frequency. Testing shall be done at an AC line frequency of 60Hz (± .5Hz). For specified service conditions requiring line frequencies other than 60Hz, design calculations and equipment part specifications shall be used to demonstrate the ability of the equipment to meet specified requirements. In lieu of the foregoing, the option of testing at all specified line frequencies may be used.

4.3.4.2 Barometric Pressure. Testing shall be done either at the barometric pressure corresponding to the maximum altitude specified under the service conditions, or at the barometric pressure prevailing at the test site; in the latter case, design calculations and parts specifications shall be used to demonstrate the ability of the equipment to meet performance requirements at the maximum altitude specified under the service conditions.

4.3.4.3 Wind and Ice Loading. Where wind and ice loading are specified under the service conditions, the contractor has the option of demonstrating compliance by any of the following means; dynamic testing, static load testing using loads which produce stresses equivalent to the specified dynamic loads, or calculations of structural strength versus dynamic stresses based on design parameters and parts and materials specifications.

4.3.4.4 Environmental (service conditions). Design qualification tests and type tests shall be conducted, as specified in Paragraph 3.2.1.3, under varying conditions without equipment adjustment, and shall be conducted with the equipment in a thermally-insulated chamber. Uniform ambient temperature throughout the chamber shall be obtained. Means of slowly circulating the air in the chamber may be provided, but violent agitation of the air resulting in rapid circulation through and around the equipment will not be permitted. The chamber shall be equipped with recording devices that will read on detachable material a continuous record of both temperature and humidity. When making the required tests, line voltage and frequency variation shall be included. Tests shall be performed with the equipment on and shall be in accordance with the following procedure:

a. Place equipment in chamber under normal test conditions (see Table XIV). Make all required tests and record all readings. No further adjustments to controls of equipment under test shall be made during Steps b through h.

b. Reduce temperature to minimum specified (or lower) at any relative humidity.

c. Begin the test at least 15 minutes after the equipment under test has stabilized at a minimum temperature, or lower, as determined by sensors located in the equipment. Finish all tests as rapidly as possible and record readings.

d. Increase temperature to maximum specified for service conditions in 5 hours or less at any relative humidity. Maintain maximum temperature, or higher, for not less than 6 hours. During this process, record all readings at approximately each 10°C rise in temperature, but not less than once an hour during the temperature increasing period. During stabilization period, record all readings once an hour with a final reading at end of the period. Where recording times exceed one hour, continuous readings shall be taken.

e. Adjust relative humidity to high humidity range, holding temperature to maximum specified. Maintain chamber at these values of ambient temperature and relative humidity for not less than 24 hours.

f. Begin tests. Finish all tests as rapidly as possible and record all readings.

g. Return chamber to normal test conditions temperature range (see Table XIV) at any relative humidity less than 80%. Equipment may now be removed from chamber, if specified normal test conditions of ambient temperature exist outside of chamber.

h. After temperature and relative humidity stabilize, allow the equipment to operate for not less than 48 hours under normal test conditions (see Table XIV). Record all readings at beginning and end of the 48-hour period.

TABLE XIV. NOMINAL DESIGN AND NORMAL TEST VALUES

PARAMETER	VALUE	TOLERANCE
Ambient temperature	+30°C	±10°C
AC line voltage	120 V 208 V 240 V	±2 V ±3.5 V ±4 V
AC line frequency	60 Hz	±0.5 Hz
DC voltage	48 V 24 V	±1 V ±1 V

i. After the complete cycle of tests the equipment shall be examined for indications of rust, corrosion, flaking of plating, deterioration of paint, and deformation of plastic materials, to determine specification compliance.

4.3.4.5 Sound Pressure Test. Equipment requiring sound pressure testing (see Paragraph 3.3.7.1) shall be tested in accordance with the procedures contained in MIL-STD-1474 and Table XV extracted from MIL-STD-1474. The following procedures shall be followed for individual equipment items:

a. Sound pressures shall be measured at a distance of three feet from the equipment being tested.

b. At least four sets of noise level readings shall be submitted. One set of readings taken opposite each of the four principal orthogonal surfaces of the equipment. No reading shall exceed the maximum as stated in Paragraph 3.3.7.1.

c. Test area data consisting of the test room volume (in cubic feet, in which the noise measurements are conducted) shall be provided. All principal surface areas of the room shall be described in sufficient acoustic detail to permit an estimation of the approximate Room Constant or Room Absorption for the space.

d. During the tests, the equipment shall be in normal operation at not less than 50% full rated load (or at a specified mutually acceptable load condition). The tests shall be carried out by the equipment manufacturer or by a FAA approved testing agency. Whenever possible, approved 'standards' of measurements shall apply.

e. Final testing for conformance to meet the tests above may be made following complete installation of the equipment at the FAA site, with the permission of the FAA, provided the contractor will remove and replace the equipment at the contractors expense, if it fails to meet the noise tests. To be acceptable, the replacement equipment must meet the noise tests. For the on-site tests, the equipment shall be in normal operation at not less than 50% full rated load (or at a specified mutually acceptable load condition). The tests shall be in accordance with the procedures documented above.

f. For all noise tests, the ambient noise level of the test area shall be at least 10 dB(A) below the level required for the equipment under test.

TABLE XV. STEADY-STATE NOISE CATEGORIES

CATEGORY RQMTS (see note)*	SYSTEM
A	No direct person-to-person voice communication required. Maximum design limit, Heading protection required.
B	Electrically-aided communication via attenuating helmet or headset required. Noise levels are hazardous to unprotected ears.
C	No frequent direct person-to-person voice communication required. Occasional shouted communication may be possible at a distance of 0.30 meters. Hearing protection required.
D	No frequent direct person-to-person voice communication required. Occasional shouted communication may be possible at a distance of 0.60 meters. Levels in excess of Category D require hearing protection.
E	Occasional telephone of radio use or occasional communication at distances up to 1.50 meters required. (Equivalent to NC-70.)
F	Frequent telephone or radio use or frequent communication distances up to 1.50 meters required. (Equivalent to NC-60.)

Note: Categories A, B, C, and D are based primarily on hearing conversation properties; the remaining categories are based primarily on communication requirements. For fixed-plant facilities, see MIL-STD-1472.

4.3.4.6 Non-Compliance with Required Noise Limits. Non-compliance with the noise limits as described above shall be acceptable only with written approval from the FAA. Newly designed equipment non-compliant with the required noise limit shall be documented based upon test requirements of MIL-STD-1474C Paragraph 5.1.1.3.2. COTS equipment non-compliance with the required noise limits shall be documented based upon the manufacturer's test results.

4.3.4.7 Flammability Test. The test used to determine the flammability of material shall be the test specified in the material specification. Since the flammability characteristics of a material may be affected by the end item configuration, the specified test may, with the approval of the FAA, be conducted on a specimen that has been mixed, blended, saturated, impregnated, layered, or otherwise processed to simulate the final configuration in the end equipment usage. If the material specification does not have such a test, materials shall be tested in accordance with ASTM D568, ASTM D635, ASTM D1000, or MIL-STD-202, Method 111, as applicable. Materials not covered by the above tests shall be tested in accordance with a procedure proposed by the manufacturer and approved by FAA. Flammability test methods shall be developed using the methods in UL 94.

4.3.5 Test Equipment.

4.3.5.1 Furnishing of Test Equipment. The contractor shall supply all test equipment necessary for the tests required. The contractor shall provide and maintain all measuring and test equipment in accordance with FAA-STD-013, FAA-STD-016, or the contract schedule, including on-site testing if installation is a requirement of the contract.

4.3.5.2 Basic Instrument Accuracy. Instruments for measurement of certain basic electrical quantities shall have the rated accuracies specified in Table XVI, or better (instrument manufacturer's rating or testing laboratory certification). The percentages given in Table XVI for indicating instruments are percentages of full scale. When using analog meters, all readings shall be made within the upper 50 percent of the scale arc.

4.3.5.2.1 Allowance for Less-accurate Instruments. As an exception to the requirement for rated accuracies in accordance with Table XVI, instruments which are less accurate, up to a limit of twice the percentage values shown in the table may be used, but only for the measurement of an electrical quantity for which a tolerance is specified, and provided that the additional instrument tolerance shall be subtracted from the tolerance specified for the electrical quantity.

TABLE XVI. BASIC INSTRUMENT ACCURACY

Resistance	See Paragraph 4.3.5.3
DC voltage, current power	± 0.5 percent
AC voltage, current, power at 60Hz (except filament/heater voltage)	± 1.0 percent
Filament/heater voltage	± 0.5 percent
Frequency, AC line (60 Hz)	± 0.5 percent

4.3.5.3 Resistance Measuring Equipment. For measurement of resistors having a rated accuracy of ± 2 percent or better (also to measure resistors of lesser accuracy to resolve questions where tolerances are apparently exceeded by a small margin), and for measurement of transformer and other parts windings for determination of temperature rise by the rise-in-resistance method, digital multimeters having ohmmeter accuracy of ± 0.1% or better shall be used.

4.3.5.4 Temperature Indicators. Temperature indicating equipment shall have an accuracy of ± 2°C or better.

4.3.5.5 Humidity Measurement Accuracy. The techniques used to measure relative humidity shall provide readings within five percentage points of true relative humidity.

4.3.5.6 Instrument Accuracy for Other Measurements. Instruments for the measurement of quantities other than those specified in Paragraphs 4.3.5.2 to 4.3.5.3 shall have actual calibrated accuracies greater by a factor of three (as a minimum) with reference to the tolerance specified for each quantity.

4.4 NDI and COTS Verifications. This subsection defines the minimum requirements for NDI and COTS products.

4.4.1 Testing. The contractor is responsible for performing or having performed all testing necessary to substantiate that the supplies provided perform to the contract requirements.

4.4.1.1 FCC Type Acceptance and Registration Procedures. Shall be in accordance with Paragraphs 4.3.2.5.1 and 4.3.2.5.2.

4.4.2 Inspection/Acceptance. Products to be delivered as COTS or NDI (intended to be used in the same environment for which it was designed) shall be considered as commercial manufactured items. As such, Government inspection and examination shall be visual, limited to count and type or other criteria as specified by contract. However, an abnormally high failure rate determined during operation and/or use shall require an in-plant quality review and report by the QRO.

4.4.3 Special Considerations.

a. When NDI or COTS products are to be used as part of a developed item or in an environment different from that for which it was designed, the contractor shall demonstrate that the NDI or COTS products operate as part of the developed item and/ in the environment specified for use as required by the contract.

b. Modified NDIs shall require testing in order to verify that the specified performance is not adversely affected by the modification.

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5.0 PREPARATION FOR DELIVERY

5.1 General. Requirements for packaging, packing and marking for shipment shall be as specified in the equipment specification or work statement and will be in accordance with MIL-STD-2073, DOD Material Procedure for Development and Application of Packaging Requirements; MIL-STD-129, Marking for Shipment and Storage; and ASTM-D-3951, Standard Practices for Commercial Packaging.

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6.0 NOTES

6.1 General. Appendix I provides guidance for tailoring the requirements for a Developmental, NDI or COTS procurement. This specification contains a set of requirements designed to be tailored for each contract by the government program office. The tailoring process for this specification is the deletion of non-applicable requirements.

6.2 Acronyms and Abbreviations. The following list contains all approved contractions and acronyms used by the NAS for the purpose of the specification.

AGMA	American Gear Manufacturers Association
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWS	American Welding Society Inc.
AC	Alternating Current
BAFO	Best and Final Offer
BIT	Built-in-Test
C	Celsius
CASE	Computer Aided Software Engineering
CFR	Code of Federal Regulations
COTS	Commercial Off the Shelf
CRT	Cathode Ray Tube
DESC	Defense Electronics Supply Center
DISC	Defense Industrial Supply Center
dB	decibel
DC	Direct Current
ECSA	Exchange Carriers Standards Association
EL	Electroluminescent
EMI	Electromagnetic Interface
ER	Established Reliability
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FPM	Feet per Minute
FRACAS	Failure Reporting, Analysis, and Corrective Action System
H_Z	Hertz
ILS	Instrument Landing System
ILSP	Integrated Logistics Support Plan
I	current
I_N	Individual Current Harmonic Distortion
I/O	input/output
LCD	Liquid Crystal Display
LED	Light-emitting Diode
LRU	Line Replaceable Unit
m	meters
ma	milliamps
mm	millimeters
MEP	Mobile Electrical Power
MPCAG	Military Parts Control Advisory Groups
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NAS	National Airspace System
NFPA	National Fire Protection Association

NPAR	Nonstandard Part Approval Request
NDI	Non-Developmental Items
NTIA	National Telecommunications and Information Administration
OSHA	Occupational Safety and Health Act
PF	Power Factor
PPSL	Program Part Selection List
QRO	Quality Review Officer
RF	Radio Frequency
RFP	Request for Proposal
RFB	Request for Bid
RMM	Remote Maintenance Monitoring
RMS	Remote Monitoring Subsystem
SMD	Standard Military Drawing
SPC	Statistical Process Control
THD_I	Maximum Total Current Harmonic Distortion
TR	Technical Report
UL	Underwriters Laboratories, Inc.
UPS	Uninterruptible Power Sets
V	Volts
VA	Volt Ampere
VSWR	Voltage Standing Wave Ratio
W	Watt
WS	Water Soluble

6.3 Index.

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APPENDIX I

10.0 TAILORING GUIDELINES

10.1 Purpose. This appendix provides guidance on tailoring the requirements contained in FAA-G-2100 to a specific project.

10.2 Tailoring Definitions. Tailoring is the process of:

a. Evaluating each requirement in the FAA-G-2100 specification to determine whether it is necessary for a given project.

b. Deleting those requirements that are not needed. Tailoring is intended to eliminate unnecessary and duplicate requirements. For standards, a modified version of the requirement may be included in the equipment specification or statement of work. For Data Item Descriptions, unnecessary requirements may be deleted or partially deleted. Requirements may be modified or added only under exceptional circumstances since this may not be cost effective.

10.3 Tailoring Responsibility. Tailoring decisions, subject to appropriate review, remain the responsibility of the government program manager. It is important for the program manager to involve all key system acquisition participants in the tailoring process. These participants will include:

a. Technical staff in, and available to, the program office, such as system engineering, software engineering, configuration management, logistics manager, quality assurance, and test personnel.

b. Contract administration and contracting office personnel.

c. User/operations personnel.

d. Support/maintenance personnel.

e. Development contractors. It is highly desirable to solicit contractor input early in the tailoring process. This may be done before the Request for Proposal (RFP), in a draft RFP or specification distributed for industry comment. Contractors may also propose tailoring in their Bid and Proposal. The contractors should also be encouraged to propose the use of non-government specifications and standards where a net benefit to the government will accrue.

f. Military Parts Control Advisory Groups. The program manager is encouraged to involve MPCAGs early in the acquisition process in order to implement an efficient and effective Parts Control Program per MIL-STD-965.

10.4 Applicability. When evaluating each requirement for a given project, the acquisition strategy is an important factor in the tailoring process. For example, the specification may be applied on a limited basis or as guidance for NDI and COTS items being procured. Columns "Develop", "NDI", and "COTS" in Table I-1 have an "X" to indicate the applicability of the specification requirement, by paragraph number and title, to procurement of a Developmental, NDI or COTS item. It should be noted that NDI, as used, herein, excludes commercial products. Requirements applicable to commercial products are indicated in the column "COTS". The absence of an "X" in a column means that the requirement has been tailored out. The footnotes in Table I-1 also show which requirements need to be modified as part of the tailoring decisions.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
1.0	SCOPE AND PURPOSE				1
1.1	Scope	X	X	X	1
1.1	Scope	X	X	X	1
1.1.1	Intended Use	X	X	X	1
1.1.2	Tailoring of this Specification	X	X	X	1
1.1.3	Classification	X	X	X	1
1.1.4	Specification Type	X	X	X	1
1.1.4.1	Performance Specfication	X	X	X	1
1.1.4.2	Design Specification	X	X	X	1
2.0	APPLICABLE DOCUMENTS	X	X	X	3
2.1	Government documents	X	X	X	3
2.2	Non-Government documents	X	X	X	3
3.0	REQUIREMENTS	X	X	X	5
3.1	General	X	X	X	5
3.1.1	Definitions	X	X	X	5
3.1.1.1	COTS[1]	X	X	X	5
3.1.1.2	Developmental Item	X	X	X	5
3.1.1.3	Fail-safe	X	X	X	5
3.1.1.4	Fail-soft	X	X	X	5
3.1.1.5	Modified COTS/Commercial Type Product	X	X	X	5
3.1.1.6	NDI (Nondevelopmental Item)[2]	X	X	X	5
3.1.2	Electrical[3]	X	X	X	6
3.1.2.1	Electrical Wiring	X	X	X	6
3.1.2.2	AC Supply Line - Circuit and Parts Requirements	X	X	X	6
3.1.2.2.1	AC Line Controls	X	X	X	6
3.1.2.2.2	Main power Switches	X	X	X	6
3.1.2.2.3	AC Line - Input Resistance to Ground	X	X	X	6
3.1.2.2.4	AC Line Connectors and Power Cord	X	X	X	6
3.1.2.2.5	AC Line Controls to be Provided[4]	X	X	X	7
3.1.2.2.6	Transformer Isolation, DC Power Supplies (non-switching)	X	X	X	7
3.1.2.2.7	Convenience outlets	X	X	X	7
3.1.2.3	Circuit Protection	X	X	X	7
3.1.2.4	Power Source[5]	X	X	X	7
3.1.2.4.1	Electrical Load Balance	X	X	X	7

1 For COTS procurements every marked item must be tailored to the procurement that is under consideration. Items marked COTS can not be used without applicability to the specific procurement being considered.

2 Many requirements that are marked can be applied to NDI procurements, or used as needed to show that they can meet, or have an 'or equal' process in place. Industry standards have been put in FAA-G-2100 that appropriate procurements should be able to demonstrate the ability to meet.

3 Paragraph (3.1.2.1.b) is more restrictive and must be imposed by the specification. Paragraph (a) is the minimum requirement. All of sections 3.1.2 through 3.1.2.4.4.5 may be applicable to NDI or COTS procurements.

4 In some uses in the air traffic control environment this requirement may need to be modified to place the power switch some place other than in the front. Human factors consideration.

5 The power source must be established by the equipment specification or statement of work (SOW).

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
3.1.2.4.2	Power Factor	X	X	X	8
3.1.2.4.3	Effect of Equipment on Power Source	X	X	X	8
3.1.2.4.4	Electrical Overload Protection	X	X	X	10
3.1.2.5	Test Points, Test Facilities, and Test Equipment	X	X		11
3.1.2.5.1	Requirements	X	X		11
3.1.2.5.2	Exceptions[6]	X	X		11
3.1.2.5.3	Locations	X	X		11
3.1.2.5.4	Protection	X	X		11
3.1.2.5.5	Failures	X	X		11
3.1.2.6	Corona Prevention	X	X		11
3.1.2.6.1	Corona Prevention	X	X		11
3.1.2.6.2	Electrical breakdown prevention	X	X		12
3.1.2.7	Grounding, Bonding, Shielding and Transient Protection	X	X	X	12
3.1.2.7.1	NDI Grounding, Bonding, Shielding and Transient Protection	X	X	X	12
3.1.2.8	Solid-State Design	X	X		12
3.1.3	Mechanical	X	X		12
3.1.3.1	Furnishing of Removable Parts and Mating Connectors	X	X		12
3.1.3.2	Installation	X	X		13
3.1.3.2.1	Pull-Out Drawers	X	X		13
3.1.3.2.2	Rack Panels	X	X		13
3.1.3.3	Construction	X	X		13
3.1.3.3.1	Storage	X	X		13
3.1.3.3.2	Moisture Pockets	X	X		13
3.1.3.3.3	Windows	X	X		13
3.1.3.4	Accessibility	X	X		13
3.1.3.4.1	Access	X	X		14
3.1.3.4.2	Connections	X	X		14
3.1.3.4.3	Parts	X	X		14
3.1.3.4.4	Enclosures	X	X		14
3.1.3.5	Thermal Design[7]	X	X	X	14
3.1.3.5.1	Air Filters	X	X	X	14
3.1.3.5.2	Exhaust Air Temperature	X	X	X	15
3.1.3.5.3	Auxiliary Heating or Cooling	X	X	X	15
3.1.3.5.4	Forced Air Cooling	X	X	X	15
3.1.3.5.5	Other Cooling Methods	X	X	X	15
3.1.4	Software[8]	X	X	X	15
3.1.5	Remote Maintenance Monitoring[9]	X	X	X	16
3.2	Characteristics	X			16
3.2.1	Performance	X			16
3.2.1.1	Continuous Unattended Duty	X	X	X	16
3.2.1.2	Design Ranges	X	X		16

6 This requirement must be tailored, or fully required, by the contract, specification, or SOW.
7 For NDI & COTS, the paragraphs in 3.1.3.5 through 3.1.3.5.5 must be tailored in by the equipment specification.
8 This requirement must be covered by the contract, specification, or SOW.
9 This requirement must be covered by the contract, specification, or SOW.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
3.2.1.2.1	Nominal Design and Normal Test Values[10]	X	X		16
3.2.1.2.2	Environmental Design Values[11]	X	X	X	16
3.2.1.2.3	Wind and Ice Loading	X	X	X	16
3.2.1.2.4	Non-Operating Conditions[12]	X	X	X	16
3.2.1.2.5	Voltage Range Test Conditions	X	X	X	17
3.2.1.3	Operation Under Varying Conditions	X	X	X	17
3.2.1.4	Fixed Adjustment Provision	X	X		18
3.2.1.5	Equipment Response to Input Power Conditions	X	X		18
3.2.2	Physical Characteristics[13]	X	X	X	18
3.2.2.1	Electronic Equipment Assembly Requirements[14]	X	X	X	18
3.2.2.1.1	Soldering and Assembly[15]	X	X	X	18
3.2.2.1.2	Component Mounting	X	X	X	18
3.2.2.1.3	Printed Boards	X	X	X	19
3.2.2.1.4	Assembly Requirements	X	X	X	19
3.2.2.2	Wire Wrap[16]	X	X	X	19
3.2.2.3	Certification	X	X	X	19
3.2.2.4	Reference Designations	X	X	X	19
3.2.3	Reliability[17,18]	X	X	X	20
3.2.3.1	Subcontractor Surveillance and Control (Task 102)	X	X	X	20
3.2.3.2	Program Reviews (Task 103)	X	X	X	20
3.2.3.3	Failure Reporting, Analysis, and Corrective Action (Task 104)	X	X	X	20
3.2.3.4	Reliability Predictions (Task 203)	X	X	X	20
3.2.3.5	Parts Program (Task 207)	X	X	X	21
3.2.4	Maintainability[19,20]	X	X	X	21
3.2.4.1	Subcontractor Control and Surveillance (Task 102)	X	X	X	21
3.2.4.2	Program Reviews (Task 103)	X	X	X	21
3.2.4.3	Maintainability Predictions (Task 203)	X	X	X	21
3.2.4.4	Maintainability Demonstration	X	X	X	21
3.2.5	Fail-safe Equipment Operation[21]	X	X		21

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10 The nominal design and normal test values must be established by the equipment specification or statement of work (SOW).

11 The environment must be decided on before applying other parts of FAA-G-2100. The environment the system is to be placed in will determine the applicability of the requirements in this specification.

12 This requirement should be tailored if the equipment cannot stand the ranges contained in the Table. Example would be equipment that use Liquid Crystal Displays may not stand the temperature ranges.

13 In paragraphs 3.2.2 through 3.2.2.4 industry standards are used which may be applicable to NDI/COTS procurements, or used as or equal processes by the contractors.

14 Class I is a consumer product level environment, use class 2 or 3. The electronic equipment must be established by the equipment specification or statement of work (SOW).

15 This is an industry standard and may be directly applied to NDI/COTS procurements, or used to require an 'or equal' process to be used by contractors.

16 For NDI and COTS, the identified paragraphs must be tailored in the equipment specification.

17 Paragraphs3.2.3 through 3.2.4.4 must be tailored in by the equipment specification.

18 The R&M value for major vendors should be validated for the contract under consideration, and the value tailored into the specification, SOW, contract.

19 Paragraphs3.2.3 through 3.2.4.4 must be tailored in by the equipment specification.

20 The R&M value for major vendors should be validated for the contract under consideration, and the value tailored into the specification, SOW, contract.

21 These requirements must be established by the equipment specification, statement of work (SOW), or contract.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
3.2.6	Fail-soft Remote Maintenance Monitor Operation[22]	X	X		21
3.2.7	Environmental Conditions[23]	X	X	X	21
3.2.8	Transportability[24]	X	X	X	22
3.3	Design and Construction	X	X		22
3.3.1	Materials, Processes, and Parts[25]	X	X		22
3.3.1.1	Materials	X	X		22
3.3.1.1.1	Arc-resistant Materials	X	X		22
3.3.1.1.2	Dissimilar Metals	X	X		23
3.3.1.1.3	Metals, Corrosion Resistance	X	X		23
3.3.1.1.4	Fibrous Material, Organic	X	X		23
3.3.1.1.5	Flammable Materials[26]	X	X	X	23
3.3.1.1.6	Fungus-inert Materials	X	X		23
3.3.1.1.7	Insulating Materials, Electrical	X	X		25
3.3.1.1.8	Lubricants	X	X		26
3.3.1.1.9	Rubber (natural)	X	X		26
3.3.1.1.10	Wood and Wood Products	X	X		26
3.3.1.1.11	Thread Locking and Retaining Compounds	X	X		26
3.3.1.1.12	Anti-seize Compounds	X	X		26
3.3.1.2	Processes	X	X		26
3.3.1.2.1	Brazing	X	X		26
3.3.1.2.2	Castings	X	X		26
3.3.1.2.3	Encapsulation and Embedment (potting)	X	X		27
3.3.1.2.4	Welding, Structural	X	X		27
3.3.1.2.5	Welding, electrical and electronic interconnections	X	X		28
3.3.1.2.6	Equipment Finish[27]	X	X		28
3.3.1.2.7	Wire Wrapped Solderless Connections	X	X		29
3.3.1.3	Parts	X	X	X	29
3.3.1.3.1	Application, Use and Orientation of Parts[28]	X	X		30
3.3.1.3.2	Derating Policy and Design Tolerance Values	X	X		31
3.3.1.3.3	Bonding, Securing, and Fastening Methods	X	X		31
3.3.1.3.4	Electrical Parts[29],[30]	X	X	X	31
3.3.1.3.5	Mechanical parts	X	X		47
3.3.1.3.6	Miscellaneous Items	X	X		55
3.3.2.2	Developmental Item	X	X	X	56

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[22] These requirements must be established by the equipment specification, statement of work (SOW), or contract.

[23] This requirement must be tailored in by the specification, SOW, or contract.

[24] This requirement must be tailored in by the specification, SOW, or contract.

[25] Paragraphs 3.3.1 through 3.3.1.3.6 would not be applicable to COTS procurements, unless selected ones could be applied to a specific COTS procurement. These may be applicable to NDI procurements that were developed using specifications similar to FAA-G-2100, or to Military standards.

[26] Requires tailoring.

[27] Specification in all cases needs to specify color requirements and selection of finish. EPA approved paints, finishes, and processes are changing too fast to put into this specification.

[28] Project office may want to require FAA approval for standard parts. This requirement should be in the equipment specification or SOW.

[29] Paragraph 3.3.1.3.4.14.3 must be tailored, or fully required by the contract, specification, or SOW.

[30] Paragraphs 3.3.1.3.4.16 through 3.3.1.3.4.16.2 must be tailored per note 15.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
3.3.2	Electromagnetic Compatibility[31]	X	X	X	56
3.3.2.1	General	X	X	X	56
3.3.2.2.1	Critical Area	X	X	X	56
3.3.2.2.2	Non-critical Area	X	X	X	56
3.3.2.2.3	Criticality Specified	X	X	X	56
3.3.2.2.4	Power Equipment	X	X	X	56
3.3.2.3	Non-Developmental Item (NDI)	X	X	X	56
3.3.2.4	Telephone Networks	X	X	X	56
3.3.3	Nameplates and Marking	X	X		56
3.3.3.1	Nameplates	X	X		56
3.3.3.1.1	Equipment Titles	X	X		56
3.3.3.1.2	Serial Numbers	X	X		58
3.3.3.2	Marking	X	X		58
3.3.3.2.1	Visibility of Parts Labels	X	X		58
3.3.3.2.2	Other Parts Markings	X	X		58
3.3.3.2.3	Panel Markings	X	X		59
3.3.3.2.4	Interior Marking Methods	X	X		60
3.3.3.2.5	Abbreviations	X	X		60
3.3.4	Workmanship	X	X		60
3.3.5	Interchangeability	X	X		60
3.3.5.1	Design Tolerances	X	X		60
3.3.5.2	Use of Standard Items	X	X		60
3.3.5.2.1	Use of Non-standard Parts	X	X		60
3.3.6	Personnel Safety and Health	X	X		60
3.3.6.1	Electrical Safety	X	X		61
3.3.6.1.1	Ground potential	X	X		61
3.3.6.1.2	Hinged or Slide Mounted Panels and Doors	X	X		61
3.3.6.1.3	Shielding	X	X		61
3.3.6.1.4	Bonding in Hazardous Areas	X	X		61
3.3.6.1.5	Guarding of RF Voltages	X	X		61
3.3.6.1.6	Interlocks	X	X		62
3.3.6.1.7	Shorting Rods	X	X		62
3.3.6.1.8	Meter Safety	X	X		62
3.3.6.1.9	High Voltage Protection	X	X		62
3.3.6.1.10	High Current Protection	X	X		62
3.3.6.1.11	Discharging Devices	X	X		63
3.3.6.1.12	Connectors, Electrical	X	X		63
3.3.6.2	RF/Microwave, X, and Laser Radiation Limits[32]	X	X	X	63
3.3.6.2.1	Applicability of Federal Standards	X	X	X	63
3.3.6.2.2	Radiation Hazards and Protection	X	X	X	63
3.3.6.2.3	Laser Radiation	X	X	X	63
3.3.6.3	Switches	X	X		63
3.3.6.3.1	Safety Switches	X	X		63
3.3.6.3.2	Momentary Override	X	X		63
3.3.6.4	Mechanical Hazards	X	X		63

[31] Section 3.3.2 through 3.3.2.4 require tailoring for NDI/COTS procurement.
[32] RFI and Radiation requirements must be tailored to the specific procurement under consideration, and the environment the equipment is to be put into.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
3.3.6.4.1	Mechanical Interconnection	X	X		64
3.3.6.4.2	Cathode Ray Tubes	X	X		64
3.3.6.4.3	Glass Fibers	X	X		64
3.3.6.5	Markings, Signs, Tags, and Symbols	X	X		64
3.3.6.5.1	Markings	X	X		64
3.3.6.5.2	Accident Prevention Signs and Labels	X	X		64
3.3.6.5.3	Marking of Radioactive Materials	X	X		65
3.3.6.5.4	Symbols	X	X		66
3.3.6.5.5	Alerts/Warnings	X	X		66
3.3.6.6	Hazardous and Restrictive Substances	X	X		66
3.3.6.6.1	Carcinogens	X	X		66
3.3.6.6.2	Dusts, Mists, Fumes, and Gases	X	X		66
3.3.6.6.3	Restricted Materials	X	X		66
3.3.6.6.4	Radioactive Materials	X	X		66
3.3.7	Human Engineering	X	X		66
3.3.7.1	Noise Criteria Requirement	X	X		67
3.3.7.1.1	Equipment for Operational Areas	X	X		67
3.3.7.1.2	Equipment for Equipment Areas	X	X		67
3.3.7.1.3	Equipment for Special Areas/Offices	X	X		67
3.3.7.1.4	Equipment for High Noise/Remote Areas	X	X		67
3.3.7.1.5	Identification of Noise Hazard Areas and Equipment	X	X		67
3.3.7.2	Ergonomic Considerations	X	X		67
3.3.7.3	Weight Lifting Limits	X	X		68
3.3.7.4	Visual Displays	X	X		68
3.3.7.4.1	Display Illumination and Light Distribution	X	X		68
3.3.7.4.2	Display Information	X	X		68
3.3.7.4.3	Display Positive Feedback	X	X		69
3.3.7.4.4	LED Displays	X	X		69
3.3.7.4.5	Flash	X	X		69
3.3.7.4.6	Display Type Consideration[33]	X	X		69
3.3.7.5	Labeling	X	X		70
3.4	Documentation[34]	X	X	X	70
3.5	Logistics	X	X	X	70
3.5.1	Facilities and Facility Equipment	X	X	X	70
3.6	Personnel and Training	X	X	X	70
3.7	Precedence	X	X	X	70
4.0	QUALITY ASSURANCE PROVISIONS	X	X	X	71
4.1	Quality System Requirements	X	X	X	71
4.1.1	NDI and COTS Items	X	X	X	71
4.1.1.1	Material Evaluation	X	X	X	71
4.1.1.2	Qualification Evaluation	X	X	X	71
4.1.1.3	Quality Conformance Evaluation	X	X	X	71

[33] The specification should specify the ambient lighting conditions that displays will operate in.
[34] Requirements in paragraphs 3.4 through 3.7 must be covered in the subsystem specification, SOW, contract.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
4.1.1.4	Process Control Evaluation	X	X	X	71
4.1.2	Developmental Items[35]	X	X		71
4.2	Verification/Compliance to Requirements	X	X	X	71
4.2.1	Availability of Applicable Documents	X			72
4.2.2	Inspection of Design and Production Status	X			72
4.2.3	Subcontract, Purchase Order and Invoice Submission	X			72
4.2.4	Certification Documentation	X			72
4.3	Testing Requirements	X	X	X	72
4.3.1	Contractors Detailed List of Tests	X			72
4.3.2	Classification of Tests	X			72
4.3.2.1	Contractors Preliminary Tests	X			73
4.3.2.1.1	Preliminary Test Data	X			73
4.3.2.1.2	Submission of Test Documentation	X			73
4.3.2.2	Design Qualification Tests	X			73
4.3.2.2.1	Rating Verification of Parts and Materials	X			73
4.3.2.2.2	Other General Specification Tests	X			73
4.3.2.3	Type Tests	X			73
4.3.2.3.1	Type Test Equipment Selection[36]	X			74
4.3.2.4	Production Tests	X			76
4.3.2.5	FCC Type Acceptance and Registration Procedures	X			76
4.3.2.5.1	FAA Acceptance Contingent on FCC Type Acceptance	X			76
4.3.2.5.2	FAA Acceptance Contingent on FCC Type Registration	X			76
4.3.2.6	Fail-safe Demonstration Test[37]	X			76
4.3.2.7	RMS Failsoft Demonstration Test[38]	X			76
4.3.2.8	Reliability and/or Maintainability Demonstration Tests[39]	X			76
4.3.3	Notification of Readiness for Inspection	X			76
4.3.4	Testing Considerations/Conditions	X			77
4.3.4.1	AC Line Frequency	X			77
4.3.4.2	Barometric Pressure	X			77
4.3.4.3	Wind and Ice Loading	X			77
4.3.4.4	Environmental (service conditions)	X			77
4.3.4.5	Sound Pressure Test	X			78
4.3.4.6	Non-Compliance with Required Noise Limits	X			80
4.3.4.7	Flammability Test	X			80
4.3.5	Test Equipment	X			80
4.3.5.1	Furnishing of Test Equipment	X			80
4.3.5.2	Basic Instrument Accuracy	X			80
4.3.5.2.1	Allowance for Less-accurate Instruments	X			80
4.3.5.3	Resistance Measuring Equipment	X			80
4.3.5.4	Temperature Indicators	X			81
4.3.5.5	Humidity Measurement Accuracy	X			81
4.3.5.6	Instrument Accuracy for Other Measurements	X			81

[35] Paragraphs 4.1.2 through 4.3.5.6 are minimum requirements for developmental items. They may be applicable to specific NDI procurements, and should be tailored by the contract as appropriate.
[36] Paragraph should be reviewed to see if changes are needed for procurement under consideration.
[37] Must be required under the specification, SOW, or contract.
[38] These requirements must be covered in the subsystem specification, SOW, or contract.
[39] These requirements must be covered in the subsystem specification, SOW, or contract.

TABLE I-1 APPLICABILITY TO PROCUREMENTS

		Develop	NDI	COTS	Page
4.4	NDI and COTS Verifications	X	X	X	81
4.4.1	Testing	X	X	X	81
4.4.1.1	FCC Type Acceptance and Registration Procedures	X	X	X	81
4.4.2	Inspection/Acceptance	X	X	X	81
4.4.3	Special Considerations	X	X	X	81

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APPENDIX II

20.0 GOVERNMENT DOCUMENTS

The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

SPECIFICATIONS:

Federal

QQ-S-365	Silver Plating, Electrodeposited: General Requirements for
W-C-375	Circuit Breakers, Molded Case; Branch Circuit and Service
QQ-P-416	Plating, Cadmium (Electrodeposited)
L-P-516	Plastic Sheet and Plastic Rod, Thermosetting, Cast
J-C-580	Cord, Electrical and Wire, Electrical (0 to 600 Volt Service)
W-C-596	Connector, Electrical Power, General Specification for
W-C-596/12	Connector, Receptacle, Electrical, General Purpose, Duplex, Hospital Grade Grounding, 2 Pole, 3 wire, 15 Amperes, 125 Volts, 50/60 Hertz
W-C-596/13	Connector, Plug, Electrical, General Purpose, Hospital Grade Grounding, 2 Pole, 3 Wire, 15 Amperes, 125 Volts, 50/60 Hertz
A-A-1419	Filter Element, Air Conditioning (Viscous Impingement and Dry Types, Replaceable)
TT-S-1732	Sealing Compound; Pipe Joint and Thread, Lead Free General Purpose
ZZ-R-765	Rubber, Silicone (General Specification)

Federal Aviation Administration

FAA-C-1217	Electrical Work, Interior
FAA-D-2494	Technical Instruction Book Manuscript: Electronic, Electrical, and Mechanical Equipment, Requirements for Preparation of Manuscript and Production of Books

Military

MIL-I-10	Insulating Compound, Electrical, Ceramic Class L
MIL-M-14	Molding Compounds, Thermosetting

MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse),General Specification for
MIL-S-61	Shunts, Instrument, External, 50 Millivolt (Lightweight Type)
MIL-T-152	Treatment, Moisture and Fungus-Resistant, of Communications,Electronic, and Associated Electrical Equipment
MIL-V-173	Varnish, Moisture and Fungus Resistant (for Treatment of Communications, Electronic, and Associated Equipment)
MIL-J-641	Jacks, Telephone, General Specification for
MIL-P-642	Plugs, Telephone, and Accessory Screws, General Specification for
MIL-G-1149	Gasket Materials, Synthetic Rubber, 50 and 65 Durometer Hardness
MIL-I-1361	Instrument Auxiliaries, Electrical Measuring; Shunts, Resistors, and Transformers
MIL-S-3644	Shaft Assembly, Flexible
MIL-L-3661	Lampholders, Indicator Lights, Indicator-Light Housings, and Indicator-Light Lenses, General Specification for
MIL-G-3787	Glass, Laminated, Flat; (Except Aircraft)
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-W-6858	Welding, Resistance: Spot and Seam
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-B-007883	Brazing of Steels, Copper, Copper Alloys Nickel Alloys, Aluminum and Aluminum Alloys
MIL-T-7928	Terminals, Lug: Splices, Conductors: Crimp Style, Copper, General Specification for
MIL-S-8805/56	Switch Assemblies, Sensitive, Interlock, Unsealed
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-W-8939	Welding, Resistance, Electronic Circuit Modules
MIL-C-10544	Connectors, Plug and Receptacle (Electrical, Audio, Waterproof, Ten Contact, Polarized)

MIL-T-10727	Tin Plating; Electrodeposited or Hot-dipped, for Ferrous and Nonferrous Metals
MIL-S-12285	Switches, Thermostatic
MIL-C-12520	Connectors, Plug and Receptacle (Electrical, Waterproof), and Accessories; General Specification for
MIL-S-12883	Sockets and Accessories for Plug-In Electronic Components General Specification for
MIL-P-15024	Plates, Tags and Bands for Identification of Equipment
MIL-C-15305	Coils, Fixed and Variable, Radio Frequency, General Specification for
MIL-F-15733	Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-S-15743	Switches, Rotary, Enclosed
MIL-F-16552	Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type)
MIL-F-18327	Filters; High Pass, Low Pass, Band Pass, Band Suppression and Dual Functioning, General Specification for
MIL-S-18396	Switches, Meter and Control, Naval Shipboard
MIL-S-19500	Semiconductor Devices, General Specification for
MIL-C-19978	Capacitors, Fixed, Plastic (or Paper-Plastic) Dielectric, (Hermetically Sealed in Metal, Ceramic, or Glass Cases), Established and Non-established Reliability, General Specification for
MIL-T-21038	Transformers, Pulse, Low Power, General Specification for
MIL-S-21604	Switches, Rotary, Multipole and Selector; General Specification for
MIL-T-22361	Thread Compound; Antiseize, Zinc Dust-Petrolatum
MIL-S-22432	Servomotors, General Specification for
MIL-S-22473	Sealing, Locking and Retaining Compounds: (Single-Component)
MIL-S-22820	Servomotor-Tachometer Generator AC; General Specification for
MIL-T-22821	Tachometer Generator AC; General Specification for
MIL-B-23071	Blowers, Miniature, for Cooling Electronic Equipment, General Specification for

MIL-I-23264	Insulators, Ceramic, Electrical and Electronic, General Specification for
MIL-T-23648	Thermistor (Thermally Sensitive Resistor), Insulated; General Specification for
MIL-I-24092	Insulating Varnishes and Solventless Resins for Application by the Dip Process
MIL-I-24768	Insulation, Plastics, Laminated, Thermosetting; General Specification for
MIL-P-25518	Plastic Materials, Silicone Resin, Glass Fiber Base, Low Pressure Laminated
MIL-D-28728	Dial, Control, Multi-turn Counters General Specification for
MIL-R-28750	Relay, Solid State, General Specification for
MIL-C-28803	Display, Optoelectronic, Readouts, Backlighted, Segmented, General Specification for
MIL-D-28809	Circuit Card Assemblies, Rigid, Flexible, and Rigid-Flex
MIL-T-31000	Technical Data Packages, General Specification for
MIL-M-38510	Microcircuits, General Specification for
MIL-M-38527	Mounting Pads, Electrical-Electronic Component, General Specification for
MIL-I-38535	Integrated Circuits (Microcircuits) Manufacturing, General Specification for
MIL-C-39003	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-C-39006	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-C-39006/22	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, (Polarized,Sintered Slug), 85 DEG C (Voltage Derated to 125 DEG C), Established Reliability, Style CLR79
MIL-C-39006/25	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum (Polarized, Sintered Slug) (Extended Range), 85 DEG C (Voltage Derated to 125 DEG C), Established Reliability, Style CLR81
MIL-C-39010	Coils, Electrical, Fixed Radio Frequency, Molded, Established Reliability, General Specification for
MIL-C-39018	Capacitors, Fixed, Electrolytic (Aluminum Oxide), Established Reliability and Nonestablished Reliability General Specification for
MIL-I-46058	Insulating Compound, Electrical (for Coating Printed Circuit Assemblies)

MIL-P-46112	Plastic Sheet and Strip, Polyimide
MIL-W-46132	Welding, Fusion, Electron Beam, Process for (use AMS 2680, AMS 2681)
MIL-S-46163	Sealing, Lubricating, and Wicking Compounds: Thread-Locking, Anaerobic, Single Component
MIL-R-50781	Resolvers, Electrical, Linear: General Specification for
MIL-C-55116	Connectors; Miniature Audio, Five-Pin and Six-Pin, General Specification for
MIL-T-55164	Terminal Boards, Molded, Barrier, Screw and Stud Types, and Associated Accessories, General Specification for
MIL-C-55181	Connectors, Plug and Receptacle, Intermediate Power (Electrical, Waterproof), Type MW, General Specification for
MIL-O-55310	Oscillators, Crystal, General Specification for
MIL-A-55339	Adapters, Connector, Coaxial, Radio Frequency, (Between Series and Within Series), General Specification for
MIL-R-55342	Resistors, Fixed, Film, Chip, Established Reliability, General Specification for
MIL-C-55514	Capacitors, Fixed, Plastic (or Metalized Plastic) Dielectric DC or DC-AC, in Nonmetal Cases, Established Reliability, General Specification for
MIL-T-55631	Transformers; Intermediate Frequency, Radio Frequency and Discriminator, General Specification for
MIL-E-81512	Encoder, Shaft Position to Digital, Contact Type, Altitude Reporting; General Specification for
MIL-B-81744	Barrier Coating solution, Lubricant Migration Deterring
MIL-S-81963	Servocomponent, Precision Instrument, Rotating, Common Requirements and Tests, General Specification for
MIL-I-83446	Coils, Radio Frequency, Chip, Fixed or Variable, General Specification for
MIL-C-83503	Connectors, Electrical, Flat Cable and/or Printed Wiring Boards, Non-environmental, General Specification for
MIL-D-83531	Delay Lines, Passive, General Specification for
MIL-T-83721	Transformers, Variable, Power, General Specification for
MIL-T-83727	Transolvers, General Specification for
MIL-S-83731	Switches, Toggle, Unsealed and Sealed Toggle, General Specification for
MIL-S-83734	Sockets, Plug-in Electronic Components, Dual-in-Line (DIPS) and Single-in-Line Packages (SIPS) General Specification for

MIL-E-85082	Encoders, Shaft Angle to Digital, General Specification for
MIL-D-87157	Displays, Diode, Light Emitting, Solid State, General Specification for

STANDARDS:

Federal

FED-STD-H28	Screw-Thread Standards for Federal Services

Federal Aviation Administration

FAA-STD-013	Quality Control Program Requirements
FAA-STD-016	Quality Control System Requirements
FAA-STD-020	Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment
FAA-STD-021	Configuration Management
FAA-STD-028	Contracts Training Programs
FAA-STD-032	Standards for National Airspace System Physical Facilities
FAA-STD-049	Fiber Optics for Communications Equipment and Systems

Military

MIL-STD-12	Abbreviations for Use on Drawings, and in Specifications, Standards and Technical Documents
MIL-STD-22	Welded Joint Design
MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification of Marking U.S. Military Property
MIL-STD-198	Capacitors, Selection and Use of
MIL-STD-199	Resistors, Selection and Use of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-248	Welding and Brazing Procedure and Performance Qualification
MIL-STD-276	Impregnation of Porous Nonferrous Metal Castings
MIL-STD-280	Definitions of Item Levels, Item Exchangeability, Models, and Related Terms
MIL-STD-415	Test Provisions for Electronic Systems and Associated Equipment, Design Criteria for

MIL-STD-454	Requirement 9 — Standard General Requirements for Electronic Equipment; Workmanship
MIL-STD-454	Requirement 76 — Standard General Requirements for Electronic Equipment; Fiber Optics
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electro-magnetic Interference
MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-471	Maintainability Verification/Demonstration/Evaluation
MIL-STD-681	Identification Coding and Application of Hook-up and Lead Wire
MIL-STD-683	Crystal Units (Quartz), Crystal Holders (Enclosures) and Oscillators, Selection of
MIL-STD-701	Lists of Standard Semiconductor Devices
MIL-STD-710	Synchros, 60 and 400 Hertz, Selection and Application of
MIL-STD-756	Reliability Modeling and Predictions
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-883	Microelectronics, Test Methods and Procedures for
MIL-STD-889	Dissimilar Metals
MIL-STD-965	Parts Control Program
MIL-STD-1130	Connections, Electrical, Solderless, Wrapped
MIL-STD-1132	Switches and Associated Hardware, Selection and Use of
MIL-STD-1261	Arc Welding Procedures for Constructional Steel
MIL-STD-1277	Splices, Terminals, Terminal Boards, Binding Posts, Terminal Junction Systems, Wire Caps; Electrical
MIL-STD-1279	Meters, Electrical Indicating, Selection and Use of
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-STD-1286	Transformers, Inductors, and Coils, Selection and Use of
MIL-STD-1334	Process for Barrier Coating of Anti-friction Bearings
MIL-STD-1346	Relays, Selection and Application

MIL-STD-1353	Electrical Connectors, Plug in Sockets and Associated Hardware, Selection and Use of
MIL-STD-1360	Fuses, Fuseholders, and Associated Hardware, Selection and Use of
MIL-STD-1388-1	Logistic Support Analysis
MIL-STD-1395	Filters and Networks, Selection and Use of
MIL-STD-1451	Resolvers, Electrical, Selection of
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment, and Facilities
MIL-STD-1474	Noise Limits for Military Materiel (Metric)
MIL-STD-1498	Circuit Breakers, Selection and Use of
MIL-STD-1516	Unified Code for Coatings and Finishes for DOD Materiel
MIL-STD-1547	Electronic Parts, Materials, and Processes for Space and Launch Vehicles
MIL-STD-1562	Lists of Standard Microcircuits
MIL-STD-1595	Qualification of Aircraft, Missile and Aerospace Fusion Welders
MIL-STD-1646	Servicing Tools for Electric Contacts and Connections, Selection and Use of
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrical Initiated Explosive Devices)
MIL-STD-2073	DOD Material Procedures for Development Application of Packaging Requirements
MIL-STD-2175	Castings, Classification and Inspection of
MIL-STD-2219	Fusion Welding for Aerospace Applications
MS33540	Safety Wiring and Cotter Pinning, General Practices for

DRAWINGS:

DESC (Defense Electronics Supply Center)

87203	Connector, Plug, Electrical, Midget Locking, Specific Purpose, General Grade, Grounding, 2 Pole, 3 Wire, 15 Amperes, 125 Volts, 50/60 Hertz (Male)
87204	Connector, Plug, Electrical, Midget Locking, Specific Purpose, General Grade, Grounding, 2 Pole, 3 Wire, 15 Amperes, 125 Volts, 50/60 Hertz (Female)

OTHER PUBLICATIONS:

FAA Orders

Order 1320.33	Equipment Modification and Facility Instruction Direction
Order 1810.6	Policy for Use of Non-developmental Items (NDI) in FAA Acquisitions
Order 3910.3	Radiation Health Hazards and Protection
Order 6950.2	Electrical Power Policy Implementation at National Airspace System Facilities
Order 6980.24	Battery Theory and Selection Guidelines

Code of Federal Regulations

Title 10,	Nuclear Regulatory Commission Regulations, Parts 0-199
Title 21,	Food and Drug Administration Regulations, Parts 1-1299
Title 29,	Occupational Safety and Health Administration Regulations, Parts 1900-1999
Title 47,	Frequency Allocations and Radio Treaty Matters; General Rules and Part 2 Regulations
Title 47,	Radio Frequency Devices, Part 15
Title 47,	Connection of Terminal Equipment to the Telephone Network, Part 68

Manual

NTIA Manual	National Telecommunications and Information Administration Manual of Regulations and Procedures for Radio Frequency Management

Handbooks

MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-251	Reliability/Design Thermal Applications
MIL-HDBK-472	Maintainability Predictions

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the government program office or as directed by the contracting officer).

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APPENDIX III

30.0 NON-GOVERNMENT DOCUMENTS

The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

STANDARDS:

AGMA Various Standards

(American Gear Manufacturers Association, 1500 King Street, Suite 210, Alexandria, VA 22314)

ANSI

ANSI J/STD-001	Requirements for Soldered Electrical and Electronic Assemblies
ANSI N2.1	Radiation Symbol
ANSI C39.1	Electrical Analog Indicating Instruments, Requirements for
ANSI Z535.1	Safety Color Code
IEEE std 200	IEEE Standard Reference Designations for Electrical and Electronics Parts and Equipment
EIA-310-D	Cabinets, Racks, Panels, and Associated Equipment
IEEE std 100	The New IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE std 315	Graphic Symbols for Electrical and Electronics Diagrams
ANSI/EIA-599	National Electronic Process Certification Standard

(American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

ASTM

ASTM G21	Determining Resistance of Synthetic Polymeric Materials to Fungi, Practice for
ASTM D 495	High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation, Standard Test Method for
ASTM B 633	Electrodeposited Coatings of Zinc on Iron and Steel, Standard Specification for
ANSI/ASTMD 568	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position
ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

ASTM D 1000	Standard Test Method for Pressure-Sensitive Adhesive Coated Tapes Used for Electrical Insulation, Methods of Testing
ASTM D 1868	Standard Test Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation Systems
ASTM D 3951	Standard Practices for Commercial Packaging

(American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103.)

AWS

ANSI/AWS A2.4	Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	Welding Terms and Definitions Including Terms for Brazing, Soldering, Thermal Spraying and Thermal Cutting

(American Welding Society Inc., 550 N.W. LeJeune Road, PO Box 351040, Miami, Florida 33135.)

ECSA

TR No. 5	Technical Report on Carrier to Customer Installation Interface Connector Wiring Configuration Catalog

(Exchange Carriers Standards Association, Suite 500, 1200 G Street, N.W., Washington, DC 20005)

EIA

EIA-JESD-23	Test Methods and Character Designators for Liquid Crystal Devices

(Electronics Industry Association, 2001 Pennsylvania Avenue, N.W., Washington, D.C. 20006)

IPC

ANSI/IPC-SM-780	Component Packaging and Interconnecting with Emphasis on Surface Mount ing
ANSI/IPC-L-108	Specification for Thin Metal Clad Base Materials for Multilayer Printed Boards
ANSI/IPC-L-109	Specification for Resin Preimpregnated Fabric (Prepreg) for Multilayer Printed Boards
ANSI/IPC-L-115	Specification for Rigid Metal Clad Base Materials for Printed Boards
ANSI/IPC-RF-245	Performance Specification for Rigid-Flex Printed Boards
ANSI/IPC-FC-250	Specification for Single- and Double-Sided Flexible Printed Wiring
IPC-D-275	Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies
ANSI/IPC-RB-276	Qualification and Performance Specification for Rigid Printed Boards
ANSI/IPC-A-600	Acceptability of Printed Boards

IPC-CM-770	Guidelines for Printed Board Component Mounting
ANSI/IPC-A-610	Acceptability of Printed Board Assemblies

(Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Ave., Lincolnwood, IL 60646)

NFPA

NFPA 70	National Electrical Code

(National Fire Protection Association, One Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101)

UL

UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 1418	Cathode-Ray Tubes
UL 1642	Lithium Batteries
UL 1950	Safety of Information Technology Equipment Including Office Electronic Equipment

(Underwriters Laboratories, Inc., Publications Stock, 333 Pfingsten Road, Northbrook, IL 60062-2096)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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APPENDIX IV

40.0 REQUEST FOR APPROVAL, PARTS AND MATERIALS

40.1 Data Requirement. When required by the specification, contract, or statement of work, the contractor shall prepare a Program Parts Selection List (PPSL) for those applicable parts listed in MIL-STD-965. The number of different part types shall be held to a minimum and the use of standard parts shall be maximized. The PPSL shall be submitted for approval to the FAA in accordance with the contract and as follows:

40.2 Parts Drawing Requirements. Sufficient data shall be furnished with the parts approval requests for a proper evaluation to be made. However, MIL-STD-100 and MIL-T-31000 shall not apply to parts procurement drawings unless the drawing requirements are specifically required by the equipment specification or statement of work for this purpose.

40.3 General.

a. Standard parts shall be listed in the PPSL shall be submitted on DD Form 2053. Standard parts as defined in Paragraph 3.3.1.3.1.1 do not require additional FAA approval. Parts proposed for use in accordance with Paragraphs 3.3.1.3.4.14.1a through 3.3.1.3.4.14.1 h may be listed in the PPSL as standard parts with approval of the FAA and then do not require non-standard part approval requests.

b. Nonstandard parts approval requests shall be submitted by preparing Part I of a DD Form 2052.

c. Parts contained in off-the-shelf equipment shall not be subjected to this procedure nor listed in the PPSL. When off-the-shelf equipment requires modification, the parts to be used in the modification are subject to this procedure.

d. The contractor shall include contractual coverage in all their subcontracts and subcontractors in all their sub-subcontracts to insure compliance with this Appendix to the same extent as the prime contractor.

e. The respective FAA government program office shall be the cognizant office over all NPAR's and is the FAA focal point for the Parts Control Program in the equipment specification and applicable contract.

f. The FAA shall be responsible for final approval and/or disposition of parts requests submitted by its contractors and for all formal contact with contractors. However, parts approved by DESC/DISC for which a contractor receives a copy of the approval transmittal letter sent to the FAA shall be considered approved.

g. The Military Parts Control Advisory Groups (MPCAGs) located at the Defense Electronics Supply Center (DESC) and the Defense Industrial Supply Center (DISC) are authorized to review and recommend disposition of parts requests submitted by contractors and act as advisor to the respective FAA procuring office in part selection and use. (MPCAGS will provide their recommendations to FAA within 14 days after receipt from the contractor).

h. Requests for information and the submittal of part approval requests for MPCAG review will be send to DESC or DISC as follows:

Commander
Defense Electronics Supply Center
ATTN: DESC-EPA
Dayton, Ohio 45444
Telephone number for general inquiries: (513) 296-5431

Commander
Defense Industrial Supply Center
ATTN: DISC-ESM
Philadelphia, PA 19111
Telephone number for general inquiries: (215) 697-3000 or 697-3007

Information on specific parts is available from personnel listed in the MPCAG Directory.

APPENDIX V

50.0 MIL-STD-1472 TAILORING GUIDE

50.1 Scope. This appendix provides a guide for tailoring MIL-STD-1472, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities". This tailoring guide provides information to both the subject matter expert and the non-expert in choosing portions of the general standard to apply to this specification.

50.2 General. MIL-STD-1472 presents design requirements for all military systems. As the general authority it contains considerable material irrelevant to electronic equipment. Further, the document is intended for system design. The FAA electronic equipment specification refers only to a discrete item. Requirements must, therefore, be translated from the aggregate to the individual.

50.3 Required Paragraphs. Tailoring Guidance consists of required paragraphs which the equipment design shall meet and paragraphs which are used as a design guidance. All other paragraphs need not be met.

MIL-STD-1472, 14 March 89

Document Title: Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

Tailoring Application: The following paragraphs are recommended to be invoked as requirements by the statement of work:

Para. No	Title	Rationale
1.	Scope	Introduction to Human Engineering requirements
4.	General Requirements	Top level requirements
5.1	Control/Display Integration	Guidance on placing controls & displays
5.2	Visual Displays	All aspects of visual information presentation
5.3	Audio Displays	All aspects of audio information presentation
5.4	Controls, General Criteria	Introduction to control requirements
5.4.1	Linear Controls	Details of linear movement control design & application
5.4.3.1.3	Keyboards	Details of keyboard design requirements
5.4.3.2	Continuous Adjustment	Details of various linear controls and control types
5.4.5	Miniature Controls	Special issues of small control devices
5.4.6	Touch Screen Controls	Special considerations for displays with touch screens

Para. No	Title	Rationale
5.5.1	Labeling, General	Overview of labeling requirements
5.5.2	Labeling, Orientation	Details of label placement and location
5.5.3	Labeling, Contents	Details of what to put on a label
5.9.1	Design for Maintainer	Overview of designing for general repair and maintenance
5.9.2	Monitoring of Items within Units	More overview of designing for general repair and maintenance
5.9.3	Adjustment Controls	Details of requirements for adjustment controls.
5.9.4	Accessibility	Details of physical accessibility requirements.
5.9.5	Lubrication	Guidance for lubrication designs.
5.9.6	Case and Cover Mountings	Overview of case and cover mountings.
5.9.7	Cases	Details on case requirements.
5.9.14.8	Connector, Spacing	Direction for connector spacing under a variety of design constraints.
5.10	Design of Equipment for Remote Handling	Overview of remote handling equipment.
5.11	Small Systems and Equipment	Overview of Design of small systems and equipment.
5.15	User-computer Interface	Computer screen design/information presentation

50.4 Recommended Paragraphs. The following paragraphs are recommended to be invoked as guidance for design by the statement of work.

Para. No	Title	Rationale
3.	Definitions of Terms	Useful for understanding MIL-STD language
5.	Detailed Requirements	The actual design requirements